The Leeds Sewage Works.

Mr. T. Hewson, M. I. C. E., Borough Engineer, Leeds, has just issued a pamphlet in which the Leeds Sewage Works are fully described, and an account is given of processes which have been tried at various times for the purification of the sewage of the town. The Borough Surveyor states that Leeds contains an area of 21,572 acres, and a population estimated in September, 1884, at 327,324. The district is hilly, and varies in level from 70 feet above Ordnance datum at the outfall at Knostrop to 535 feet above. The whole borough is sewered with the exception of a part of Bramley, and the townships of Beeston and Farnly, where sewers are, however, in progress. The rainfall and consumption of water are two important matters in connection with the sewers. The average rainfall during the past fifteen years has been 28.04 inches per annum. The present consumption of water is eight and a half millions of gallons per day, viz., three millions for trade purposes and five and a half millions for domestic purposes, the latter averaging 17 gallons per head of the population. When the Corporation purchased the water-works from the company in 1852, they consisted of a storage reservoir at Eccup, with a capacity of 250,000,000 gallons, a service reservoir at Weetwood, and one on Woodhouse Moor. The Corporation now possess four storage reservoirs, with a total surface area of water of 624 acres, and a capacity of holding 3,976,000,000 gallons. The great advantage which ensues from the large storage reservoir constructed at Eccup is that in case of accident to the works in the Washburn valley, there would be close to the town a supply of water equal to five or six months' consumption, supposing that not a drop of water entered from the gravitation or pumping systems. A further advantage consists in the greater time in which the water has to become clear before being sent on to the filter-beds. It is worthy of remark that Eccup Reservoir alone is of greater capacity than the whole of the subsiding, storage and service reservoirs now in use for the supply of water to London. In addition to the water from the reservoirs, the Corporation have power to take by pumping 6,000,000 gallons per day from the river Wharfe. A pipe, however, has been fixed from the junction of the Washburn with the Wharfe—into the former 10,000,000 gallons per day have to be sent from Lindley Wood Reservoir—and the 6,000,000 gallons in case of need, would be taken from the pure water of the Washburn, and not from the Wharfe. The total cost of the water-works, up to end of the last financial year, was 1,523,520*l.* At the end of August last, 78,645 houses were supplied with water. There are 15,889 water-closets, 4,392 trough (water) closets, and 3,384 pail-closets in use in the borough.

The flow of sewage is 10,000 gallons per twenty-four hours. In times of slight rain the flow increases to the rate of 24, 29, 38 and 45 millions of gallons per day; and after a morning of really heavy rain, Mr. Filliter, C. E., has found the flow to be at the rate of 110 millions of gallons per day. Mr. Hewson details the means which have been adopted to deal with the rainfall when it has become too great for the intercepting sewers to carry. This is done by diverting, in either of two ways, the extra volume of water into the nearest natural streams. The method has the advantage of preventing all flow to the sewage works after the determined degree of dilution has been arrived at. It secures a diversion of the flow without loss of head or fall, or material backing up. The number of people using water-closets and trough-closets in Leeds is 176,324, or rather over half the total population. The quality of the Leeds sewage is said to be rather poor. It contains refuse from tanneries and dyeworks, which colors it red, and which experimenters in purification have found difficult to destroy.

The question of constructing a proper system of drainage in Leeds was first entertained by the Corporation in 1842, on a plan and report furnished by Captain Vetch. These were not accepted, however. In 1845 Mr. J. W. Leather propounded an elaborate scheme, which was adopted, and the contracts for the main sewers were let in 1850, and completed in 1855. Since then numerous sewers have been, and are continually being laid. The total length is about 245 miles, and their total cost to September 1, 1884, has been 501,730*l.* The outfall sewer at Knostrop, two miles and a quarter from the Town Hall, terminates with a length of 1,550 yards, 8 feet wide by 7 feet 9 inches high, and has a gradient of 1 in 1,633. As soon as the main sewers were finished in 1855, the whole of the sewage was brought to one outfall, and the residents and property-owners near the river Aire, below Leeds began to complain of the serious nuisance. A committee of the Corporation made inquiries as to the best means of purifying and deodorising the sewage. Mr. Filliter reported in favor of obtaining 6,000 acres of land at Thorne Waste for irrigation purposes. There would in that case have been a conduit twenty-seven miles long, with three iron aqueducts. The sewage would reach Thorne Waste by gravitation in twenty-four hours. The estimated cost of the scheme, including the purchase of 2,000 acres of land, was 258,000*l.* As an alternative scheme, he recommended the "deposition" system, the tanks to be at Knostrop, and the cost 34,660*l.* The Corporation Committee still pursued its inquiries, but its action was quickened in 1870 by an injunction obtained by the riparian land-owners below the sewage outfall, to restrain the Corporation from permitting the sewage of the borough to flow into the Aire until it had been sufficiently purified so as not to be a nuisance, or injurious to health.

In August, 1870, the Corporation entered into an agreement with the A B C, or Native Guano Company. The former were to construct works to purify 2,000,000 gallons of sewage per day, at a cost not exceeding 6,000*l.*, exclusive of land. If the process turned out successful the corporation were to enlarge the works at a further cost of 14,000*l.*, so as to purify 12,000,000 gallons per day. If the company made any profit they were to pay the Corporation 5 per cent. upon the cost of the works. The Corporation performed their part of the agreement. There was no profit, however. The sewage cost 7*l.* 5*s.* per 1,000,000 gallons to purify, and it was found difficult to sell the manure at a remunerative price. The effluent water was bright and clear, and free from taste or smell. The company began its purifying operations in October, 1871, and in March, 1873, it asked to be released from its contract. This was agreed to by the Corporation on the condition that the latter were allowed to use all or any of the company's patents free of royalty. During that year Mr. Fulda and General Scott separately experimented at Knostrop, and in the next year Mr. Rupert Goodall of Armley, was very successful in cheapening the process of purification. Hearing of his success, the A B C Company asked to be allowed to have another trial. Towards the end of 1875 Mr. John Hanson, of Dewsbury, arranged with the corporation to try his newly-patented process, but in April, 1876, his process was discontinued also. The A B C, or Native Guano Company, had a third trial in 1876, which closed the experimenting period. The Corporation then took the matter in their own hands, and, by using lime only, in the quantity of 1 ton to 1,000,000 gallons of sewage, succeeded in securing clear effluent water at the smallest cost yet attained. The works at Knostrop have been fully utilized, and additions have been made from time to time. The total area of the site is over 26 acres, of which nine remain for future extensions. The permanent works consist of twelve workmen's cottages, a straining-tank, engine and boiler house, chimney-shaft, mill-house, warehouse, lime-shed, twelve depositing-tanks, a shallow reservoir or pond about five acres in area, a mud-pump, mud-tanks, and drying-cylinders. There are four steam-engines on the premises. It was at first expected that the residum would sell quickly to farmers, as it is an excellent manure. It was dried in heated cylinders at a cost of 4*s.* 6*d.* per ton, but, as there was no market for it at this increase of price, this process has been discontinued, and now, after the sludge has become dry enough in the mud-tanks to be spaded and barrowed, it is removed to the adjoining bank of the river, from whence it is taken away per boat and cart.

The analysis of the dried sludge, as now sold, made by Mr. Fairley is given below. The sample contains, in 100 parts:—

Moisture	46.94
Organic matter and salts of ammonia	14.30
Phosphates of lime, magnesia, etc	traces
Silicious matter	6.48
Sulphate of lime	1.12
Carbonate of lime, alkali, salts, etc	30.66
Total	100.00
Containing nitrogen	0.92
Equal to ammonia	1.12
Containing phosphoric acid in the soluble form equal to soluble phosphate	none

The quantity of fluid sludge pumped from the tanks daily averages 120 tons. This quantity yields 25 tons of dried manure, *i. e.* ready for sale, and having 46.94 of moisture. The sewage sludge largely accumulated so long as any charge was made for it, but no charge is now made, and farmers remove all that is made. The price of lime delivered is 12*s.* 9*d.* per ton. The lime is analysed when dry, to contain 98 per cent. of pure lime. The price of coal—best nuts—delivered, is 7*s.* per ton. The following table shows the cost of sewage works for year ended August 31, 1884:—

Pumping.

	£	s.	d.
Wages	365	12	0
Coal	322	1	7½
Pumps repairing	149	19	6
Oil, paint, and tallow	51	15	4
Iron bars, piping, etc	30	4	5
Repairs	14	0	0
Leather valves, etc	27	4	0
Lubricators	17	4	0
Brushes and matting	4	8	11
Blanketing	2	0	0

Purification.

Lime	1,179	2	1
Wages	1,782	5	9
Coal	93	0	4½
Oil, paint, and tallow	25	17	8
Iron bars, piping, etc	20	0	0
Repairs	15	2	0
Lubricators	5	0	0
Brushes and matting	2	0	0
Trap hire	21	2	0
Timber	13	4	0
Wire	11	1	0
Water-boots	10	4	0
Hose, etc	7	13	0
Medical officer	5	17	2
Office concreting	4	16	0
Grass-clipper	1	16	0
Rents, rates, and taxes	757	17	2
	4,949	8	0

There are thirty-one persons employed in various capacities at the Knostrop Sewage Works. The total cost of the works has been 57,524*l.*—London *Sanitary World.*

Smoke Testing of Drains.

The only objection to the smoke-test for drains, hitherto, has been that it was troublesome and expensive to apply, chiefly owing to the weight of the apparatus used in applying it. It has been considered necessary to generate the smoke in an iron vessel on the surface of the ground, and from thence to pump it down by means of a centrifugal pump, or fan, into the drain to be tested. As both the generating vessel and the pump were heavy, the use of them involved the necessity of the engineer's going to and from the house to be tested, in a cab, and also taking an assistant with him to work the pump. Acting upon a suggestion thrown out by my friend Mr. A. B. Brown, the eminent hydraulic engineer, of Edinburgh, that the smoke required might be generated inside the drain by means of a "rocket," I have lately devoted a good deal of time to designing cases of different shapes and sizes, and getting them made and filled with a suitable composition by Mr. James Pain, the well-known fire-work maker. On Saturday, in Christmas week, several of the engineers of the London Sanitary Protection Association, and myself met Mr. Pain's representative at an unoccupied house in Kensington, to try a number of different sizes and shapes of "smoke rockets," and give Mr. Pain an order for the one which seemed most suitable. The one fixed upon is 10 inches long, 2-14 inches in diameter, and with the composition "charged rather hard" so as to burn for ten minutes. This gives the engineer time to light the fuze, insert the rocket in the drain, insert a plug behind it, and walk through the house to see if the smoke escapes into it at any point, finishing on the roof, where he finds the smoke issuing in volumes from the ventilating pipes. The house experimented upon on Saturday had three ventilating pipes, and the smoke issued in dense masses from each of them, but did not escape anywhere into the house, showing that the pipes were sound. If the engineer wishes to increase the severity of the test, he throws a wet cloth over the top of the ventilating pipe, and so gets a slight pressure of smoke inside it. The "smoke rocket" is not protected by any patent, and if any person wishing to try it writes to Mr. James Pain, 1 St. Mary Axe, E. C., for "Innis' Smoke Rocket," specifying the size, he will be supplied with any quantity. The plug used with them is made by Mr. Francis Botting, of No 6 Baker Street, and consists of two short frustra of cones put together small end to small end, with a central screw to draw them together, and a large rubber ring, such as one sometimes sees on fetlocks of horses, round the circumference, so that screwing up the screw expands the ring, and unscrewing it allows it to contract. This plug answers for applying the water-test to drains as well as for the smoke-test.—*Cosmo Innis in the Journal of the Society of Arts.*

STEEL instead of wooden supports have been introduced in collieries. Large sections of channel-steel are used for roof beams in pit workings, and these are supported by steel props. Steel beams and props are more costly than those of wood, but the increased outlay is supposed to be more than counter-balanced by the fact that they can be easily removed uninjured for future use, and by the further advantage that their comparative lightness permits of a better working headway than is possible with the present cumbrous wooden timbering.

ENGINEERING NEWS three months for One Dollar.

From Suakim to Berber.

Written for ENGINEERING NEWS.

In February, 1875, I received from General Stone, Chief of Staff, an order to join the expedition of Colonel Colston in the Soudan. At the time, I was serving as chief of the geographical and topographical section in the General Staff Bureau of the War Office at Cairo. Colston had gone up the Nile, and was to cross the steppes from Debbeh, near Korti, to El Obeid, in Kordofan, and thence to make his way westward to Darfour. Where I should find him could not be foretold, but my quickest route was by Suakim, Berber and Khartoum. General Stone never missed a chance to get information, and I was ordered to make a careful reconnoisance of the Suakim-Berber route, "noticing particularly the water supply." I sailed down the Red Sea on an Egyptian transport crowded with Bashi-Bazouks and Egyptian infantry bound for Darfour, the conquest of which was then going on. Shortly after leaving Suez I discovered that the ship's chronometers had run down, and that the navigating officer hardly knew the difference between a sextant and a shot-gun; but the sea was like glass, and the last week in March we twisted safely through the coral reefs that lock the harbor of Suakim, on the 14th of April I arrived at Berber. My journey was made, therefore, precisely at the season of the year when the British movement across the desert may be expected to begin. The sun was near the zenith and no rain had fallen in the mountains for two years. The heat was at its maximum and the water supply at its minimum. The average temperature for the first seventeen days of April was:

	Wet Bulb.	*Dry Bulb.*
7 A. M.	69°	80°
3 P. M.	76°	99°

The highest recorded temperature that I find in my notes was 105° in the shade at 2 P. M. of April 7th. The wet bulb, at the same observation, marked 79°. Probably this temperature is lower than most people would expect to find in an African desert at the hottest season of the year, but it must be remembered that this heat is constant, day in and day out, and that one does not march in the shade, but exposed to the vertical rays of the sun shining in a cloudless sky, and to the heat and glare reflected from an herbless plain. On the other hand it will be noticed that the difference between the wet and dry bulbs reaches 26°.

From Berber I sent to General Stone the map and profile shown herewith, and the report, from which I condense some notes of the route.

The small scale sketch map is from a recent war map, and while not strictly accurate gives a good general notion of the geography of the region.

In making the map of my route the longitude of Suakim was taken from English charts and the latitude was from my own observations which differed from the English charts by twenty-two seconds. The latitude was determined at Ariab, by twenty-one observations of stars north and south of the zenith, and at Meherif (the port and official residence of the Mudir of Berber) by twenty-five observations. The longitude of Meherif was taken from the map of Manuel, the best in existence at that time. I had carried chronometers from Suakim to Berber, and the difference of longitude as obtained by them was but seventeen seconds greater than that given by Manuel; but I considered this result accidental. The line of the route was kept by prismatic compass bearings and by marching time. The barometrical observations for altitudes, were made with two aneroids. All observations were reduced to seven o'clock A. M. by carefully determined tables of hourly corrections. The hourly oscillation of the barometer as we approach the Equator becomes a very important element in determining the altitude. A table which I made at Berber showed an extreme range of 0.139 of an inch, between the highest and lowest barometer. The altitudes were computed from the method given in Lee's "Tables and Formulæ,"—that wonderfully useful publication of the U. S. Corps of Engineers. I state these facts that the reader may understand what value to attach to the plat and profile.

Caravans leaving Suakim for Berber start from the wells, about two miles inland, which are the only water supply for the town. For fifteen miles the route lies across a smooth level plain covered with gravel and small boulders. The rise from the sea is about 850 feet in this fifteen miles. The surface of the plain is frequently crossed by the beds of streams which flow from the mountains during the hard rains. These water-courses are never deep. It is well to say here, that two or three years often pass without rain in these mountains, and that the water-courses shown on the map are dry except at short and infrequent periods. Small acacias, six to twelve feet high, are scattered over the plain, but there is no other vegetation.

Nine miles from Suakim are the wells of Handouk and six miles further those of O-Taou. These will each supply 300 or 500 men and their animals. At Handouk we pass the first foothills and at O-Taou we enter the mountains. The route is up a valley one or two miles wide in places, often narrowing to the boulder bed of a mountain torrent. About twenty miles from Suakim, and about 1,000 feet above the sea, we enter the small valley of Sinkat, where are the wells of Hambouk, water-holes three feet deep, filling slowly, and when I was there kept drained by 200 men and their horses and 300 camels. Even then, however, after two rainless years the valley furnished fair browsing for camels and goats. Thirty-two miles from Suakim is the divide between the valleys of Sinkat and O-Mareg. Schweinfurth considers this the divide between the Red Sea slope and the Nile; this I doubt. It is about 1600 feet above the sea, instead of over 3000 as Schweinfurth makes it. Here is the first difficulty in building a railroad. For some miles the pass is narrow and crooked, and the grades steep. Masonry would be required to protect the road-bed from the wash of the torrent, and possibly there may be trouble in getting practicable grades without rock-cutting. The defile is an extremely ugly one to pass in the face of an enemy.

For twenty-five to thirty miles the route lies through small valleys with a considerable growth of low trees and shrubs,—acacias, and dragon-trees—passing the wells of Disibil which could supply but 100 or 200 men, and at about sixty miles from Suakim we come to the short but steep and narrow pass between Wady Ahmed and Wady Haratree. This is the summit of the line, and the most formidable obstacle to a railroad. The altitude is a little more than 3,000 feet. Here some heavy cutting would be unavoidable unless another pass could be found. In the valley of Heratree are the first large wells after leaving Suakim. These are the wells Tamai and Salalaat, sixty-two and seventy-five miles from Suakim. They are curbed with timber and furnish a large quantity of good water. In this region the route is through barren, treeless valleys, strewn with fragments of trap and porphyry. At eighty-seven miles from Suakim is a steep winding pass which leads into Wady Kokreeb. The altitude here is about 2,500 feet. This pass is the last point on the line where any difficulty would be found in locating or building a railroad. About thirty miles of marching through barren plains and low granite hills brings us to Wady Ariab, 118 miles from Suakim and 1,900 feet above the sea. We pass two or three insignificant water holes, and twenty-one miles before reaching Ariab is the well of Abd-el-Hab furnishing a large quantity of good water. It is to Ariab that it is now proposed to build a military railroad. This little valley is a genuine oasis. There are many beautiful mimosa trees and good browsing for camels and goats, and amongst the herds of the Bedouins encamped here I saw a few beeves, the only ones I believe between Suakim and Berber. Twelve miles from Ariab we leave the declining mountains, and for over forty miles further the route is over barren plains with occasional masses of low hills, till we reach the dunes and wells of O-Baek. In this fifty-four miles there is no water. The sand dunes of O-Baek are about five miles across and rise seventy-five or eighty feet above the plain. In these hills are numerous small wells constantly filling and being dug afresh. When first sunk they yield drinkable, but brackish water, which gradually becomes unfit for use. From O-Baek to the Nile sixty-eight miles, stretches a stony plain without water, tree or herb. Two hours march from the Nile is Bir Mahobe a large well of fine water.

In these notes I have indicated, as I believe, every well on the ordinary route between Suakim and Berber. In my report I suggested, as General Stone had directed, the points at which the water supply could probably be increased, and one or two at which it seemed worth while to try to make new wells; but it did not seem likely that the supply could in any way be so increased as to make the route a practicable one for a large body of men. To-day the conditions must be essentially what they were eight years ago. For seventy-five miles from Suakim, at no one point could a force of 2,000 or 3,000 men with their animals find water for their needs. There are two absolutely waterless stretches, after leaving Bir Ariab, of fifty miles each. A large body of men must, then, carry three days' water, twenty days' food, at least fifteen days' forage, and a large amount of ammunition.

We now understand why Wolseley chose the tedious Nile route rather than attempt to march his expedition through the defiles of the Suakim-Berber range, encumbered as he must have been by a great train. Of course there are many wells in the mountains known to the Arabs, who could scatter to drink and concentrate to fight, at their own pleasure. While Wolseley's campaign seems to have been conducted with no provision for the contingency of defeat, defeat in the desert mountains of the Arabian chain would have been annihilation.

At last the English Government seems to have decided to begin the campaign at the right end, and build a railroad.

In concluding my report to General Stone I said "A line of 400 kilometers which places the produce of the Soudan at once in a seaport * * * needs no advocate. Its advantages are so great and obvious that many projects for its construction must have been entertained, and among these the line from Suakim to Berber must have received attention * * * * Throughout far the greater part of the distance a railroad could be built with unusual ease and economy, and from my hasty examination of the line it seems so obvious a position, and so easy a route, that the more I think of it the more diffidence I feel in presenting my opinion of it, thinking that some great and apparent objection must have escaped my notice * * * Whoever pronounces it impracticable should be prepared to support his opinion with such evidence as can only be procured by an instrumental examination of the points indicated."

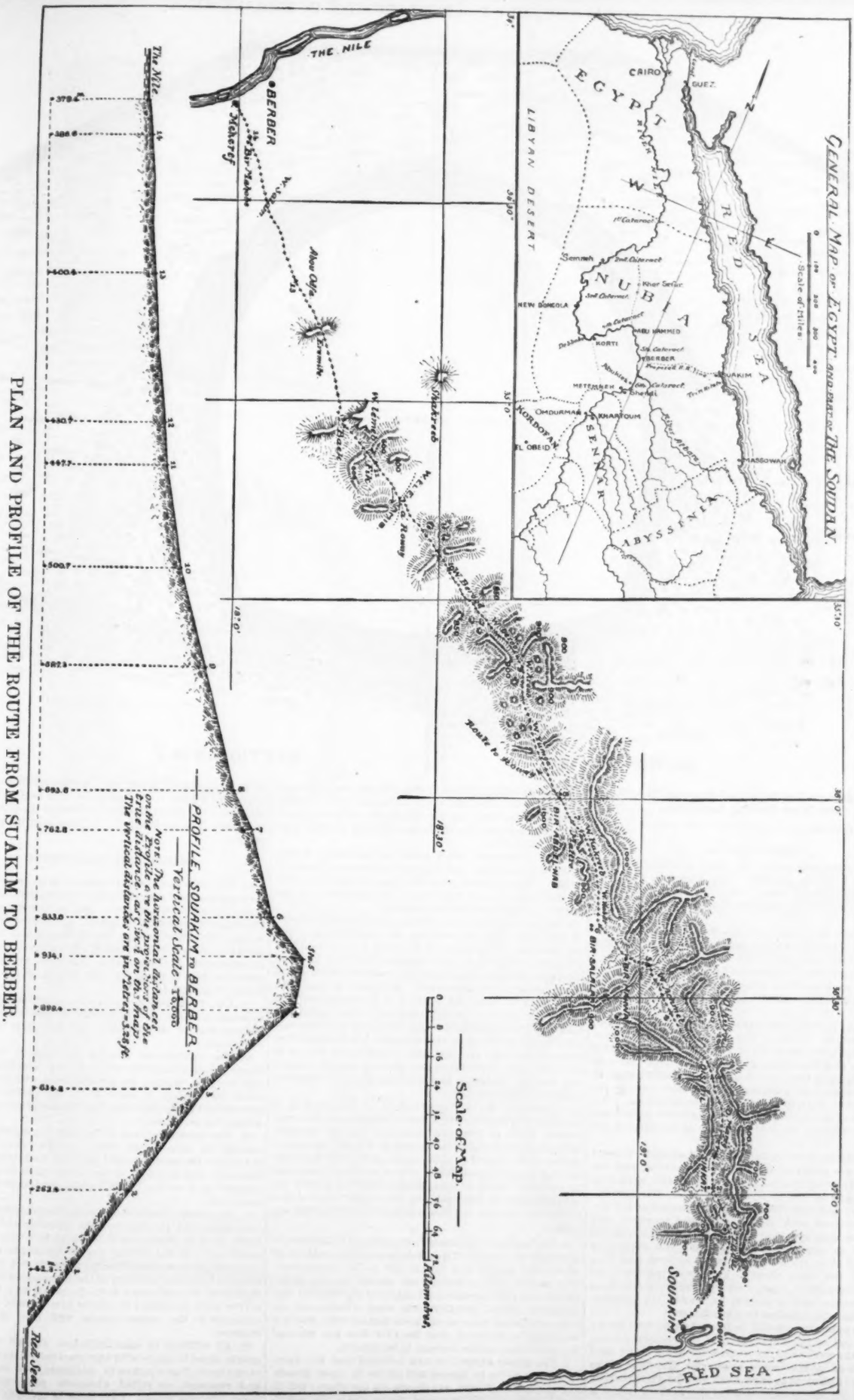
Of course there was an immense objection to this line, as I knew perfectly well at the time. Egypt had no navy. The Khédive did not wish to put the key to the Soudan in the hands of the Sultan, or of England, or Italy; nor did he wish the commerce of the Soudan to be diverted from the Nile valley.

As to the cost of the line I will venture no opinion. The reader has now all the data that I have. All labor and material must be taken from Europe. Iron ties must be used, as the white ants would destroy wooden ones. There is not an ounce of fuel to be had in the country. Surveys must be made as the line advances, involving costly mistakes and tedious delays. But when the road is built the Mahdi is "smashed;" and the restoration of order in the Soudan would be quickly followed by profitable and growing commerce.

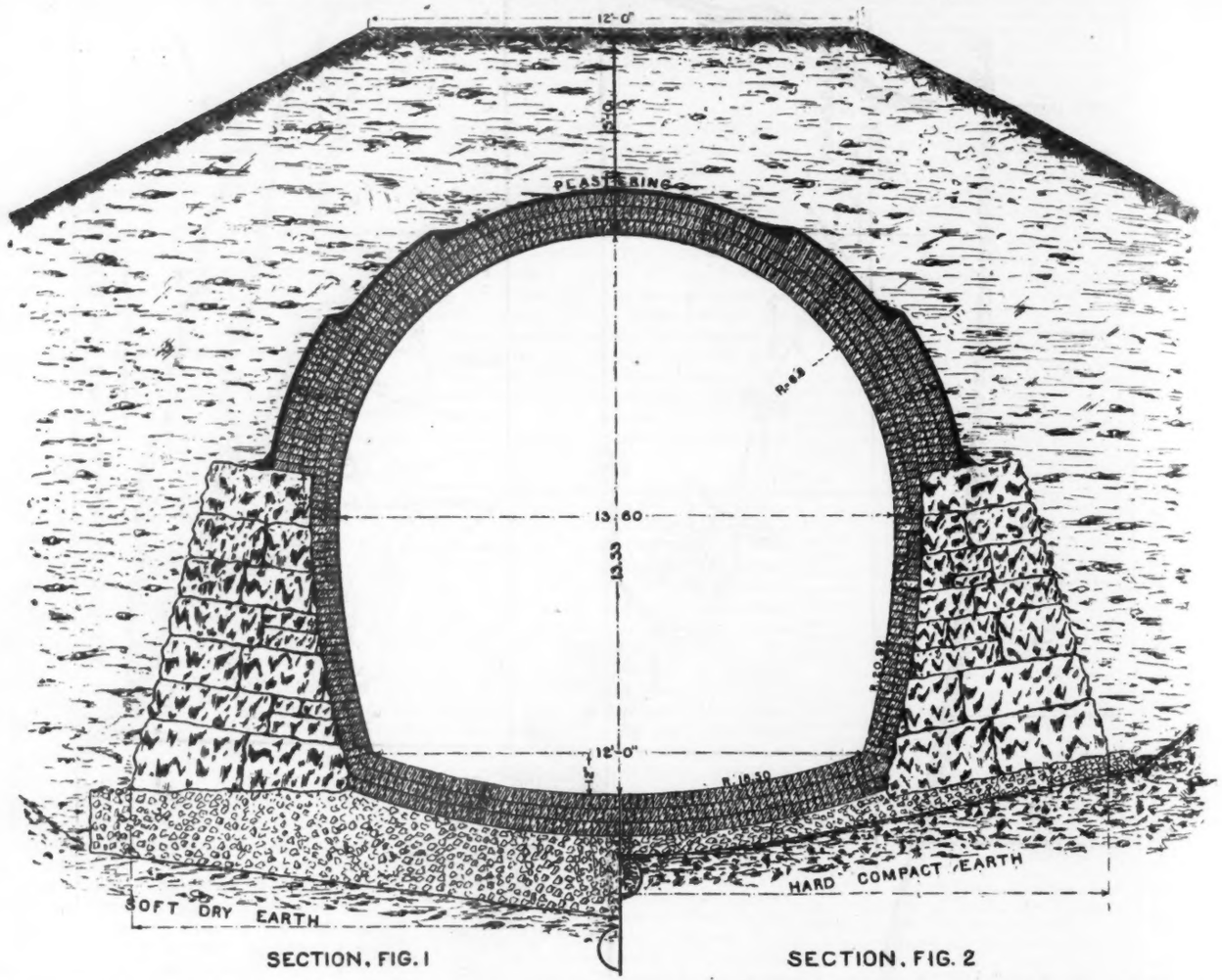
The remarkable project of a pipe line hardly calls for comment after what I have written. Without a railroad it cannot be built or maintained. In no other way than by a railroad can the machinery, pipe and coal be carried. As the line advances the pipes must stand practically empty until the Nile is reached, and water pumped back.

H. G. PROUT

Sometime Colonel of the General Staff, Egyptian Army.


GENERAL MAP OF EGYPT AND PART OF THE SOUDAN.
CAIRO
SUEZ
EGYPT
LIBYAN DESERT
NUBIA
RED SEA
Scale of Miles
Semneh
Khor Seriar
NEW DONGOLA
ABU HAMMED
KORTI
BERBER
SUAKIM
METEMMEH
Shendi
OMDURMAN
KHARTOUM
KORDOFAN
EL OBEID
SENNAR
ABYSSINIA
MASSOWAH
THE NILE
BERBER
Makerrif
Bir Mahob
New Oasis
Wadi Hamid
Wadi Abu Ruseis
Wadi Gabeit
Wadi Kamour
Wadi Kamour Pass
Wadi Kamour Well
Wadi Kamour Peak
Wadi Kamour Plain
Wadi Kamour Hills
Wadi Kamour Valley
Wadi Kamour Mountains
Wadi Kamour Desert
Wadi Kamour Oasis
Wadi Kamour Spring

NEW CROTON AQUEDUCT; CROSS-SECTION IN EMBANKMENT.



SECTION, FIG. 1 SECTION, FIG. 2

Specifications for Building Section No. 9, of the New Croton Aqueduct.

(Selected as a typical section of the work.)

SPECIFICATIONS.

1. The plans referred to in these specifications are twenty in number, entitled "The Aqueduct Commission, Westchester County," etc., Nos. 1. 2¾, 6⅛c. 25 & 31 signed by the Chief engineer, and dated October 20th, 1884.

They show the location of the work, and its *general* character. During the progress of the work, working plans will be furnished by the Engineer.

2. Section 9 of the Aqueduct to be built under this contract extends from point *G* to point *c* marked on Sheet No. 2¾ of the plans, a total distance of about 17,-432 feet.

All work, during its progress, and on its completion, must conform truly to the lines and levels given by the engineer, and must be built in accordance with the plans and directions given by him from time to time, subject to such modifications and additions as he shall deem necessary during its execution; and in no case will any work in excess of the requirements of the plans, or of the specifications, be paid for unless ordered in writing by the engineer as hereinafter set forth.

The contractor is to furnish all materials (except such as are obtained from the excavations; and the iron, and station plates, herein specifically agreed to be furnished by the City,) and all tools, implements, machinery and labor (necessary or convenient for doing all the work with safety to life and property, and within the time specified herein,) required to construct and put in complete working order the section of Aqueduct above specified, and is to perform and construct all the work covered by this agreement; the whole to be done in conformity with the plans and these specifications; and all parts to be done to the satisfaction of the said Aqueduct Commissioners.

3. Dumping grounds will be furnished by the City for the disposal of the materials to be excavated, and not used in the work; and the contractor shall dump said materials on such grounds under the direction of the engineer; sufficient ground shall also be furnished by the City for the establishment of the working plant at the shaft sites.

4. The necessary rights of way between the highways and the shaft sites and open trenches are to be furnished by the City, but the contractor is to build, repair, and maintain the roads used by him for the purpose of his work.

5. The contractor shall erect and maintain fences along the roadways, and around the grounds occupied by him. These fences must be of such a character as to be sufficient, in the opinion of the engineer, for the protection of the adjoining property.

6. Before opening the trenches, or beginning the work at the shaft sites, or building the embankments, the soil covering the location of the work is to be removed whenever directed by the engineer and put in spoil banks, to be again placed over the restored surface and the enbanksments, or wasted. Wherever an embankment is to be built, the ground is to be grubbed and freed from all trees, brush, roots, and other perishable matter. The quantities of soil removed will be measured in the spoil banks, and the price herein stipulated to be paid for the removal and replacing of soil is to cover the cost of grubbing and clearing and of removing, storing, replacing and wasting the soil, wherever ordered by the engineer.

7. Whenever in the prosecution of the work it is necessary to interfere with roads or railroads, the contractor shall at his own expense provide suitable bridges or other sufficient crossings for the accommodation of the travel on said roads; and shall maintain the same in good and safe condition until the roads can be restored; when all bridges and other temporary expedients shall be removed, and the roads restored to a condition suitable for use, and satisfactory to the engineer.

8. Borings have been made, on portions of the line, to ascertain the nature of the underground strata through which the shafts and tunnel are to be constructed. The results of these borings are shown on the plans; but should the character and extent of the various materials be found to differ from what is indicated, the contractor shall have no claim on that account, and it is expressly understood that the City does not warrant the indications of the borings to be correct.

9. The places where it is now believed that the excavations is to be in tunnel and where in open trench, and the limits of each, are shown on the plans; but if, in the opinion of the engineer, the nature of the material to be excavated at any point, or the conditions of the case shall render it advisable, he may require the excavation to be made in tunnel, although the plans indicate that it is to be made in open trench; and *vice versa*.

TRENCHES AND EMBANEMENTS.

9*a*. The contractor shall excavate open trenches for the aqueduct or for the structures connected therewith to the lines that will be given, and he is to support and maintain them and to keep the excavation free from water. The clear bottom width, length and depth of the excavation is to be established by the engineer, and in estimating the quantities excavated no allowance whatever is to be made for side slopes, or for falls or slides of any kind.

9*b*. The cross-sections for the measurments of trench excavation are to be determined by the width of the bottom, and by vertical sides, for the whole length of the trench.

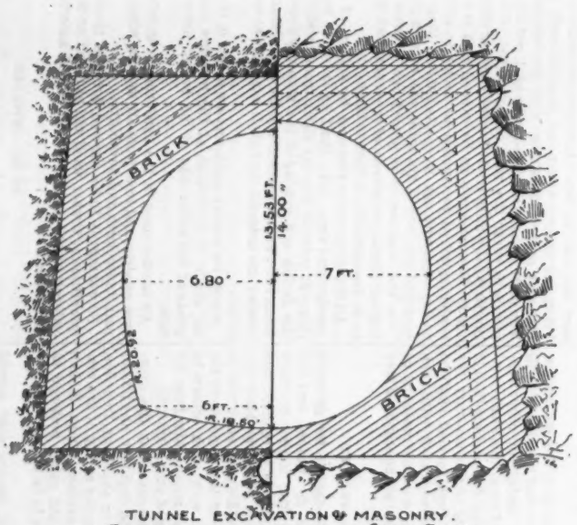
9*c*. The excavations for the channels to be made above or below the waste weirs, or any other excavation that may be ordered by the engineer with slopes or other forms, shall be made to the lines given by him, and be paid for by the cubic yard of material contained within the said lines.

9*d*. Two prices only are to be paid for materials excavated in open trench, viz.: *One for "Rock,"* which is to cover the excavation of all solid rock removed by blasting, and boulders of one cubic yard or more in volume; and *one for "earth,"* which is to cover all other materials.

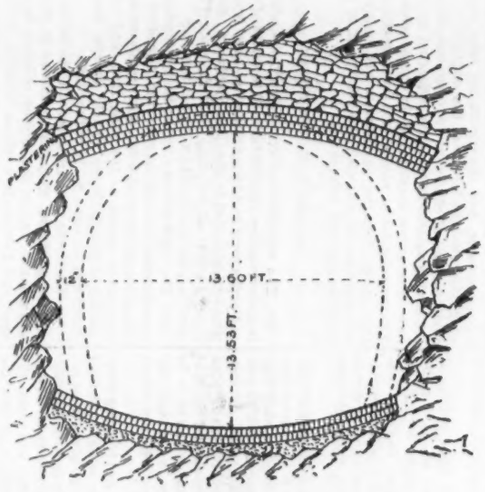
9*e*. The work of excavation in the trenches must be so conducted that the masonry can be safely and conveniently built in them, and if owing to cave-ins, or other accident, or to the giving way of timbering or other supports, or to any other cause, there is not sufficient room to build the masonry of the dimensions shown on the plans, the contractor is to do, at his own expense, all the work necessary to enable him to build the said masonry to the proper grade and line in a safe manner.

9*f*. All refilling in open trenches, and all embankments, must be made with approved materials, in layers of not more than 6 inches in thickness, well moistened and rammed; or rolled whenever practicable, with heavy grooved rollers Care must be taken to keep the

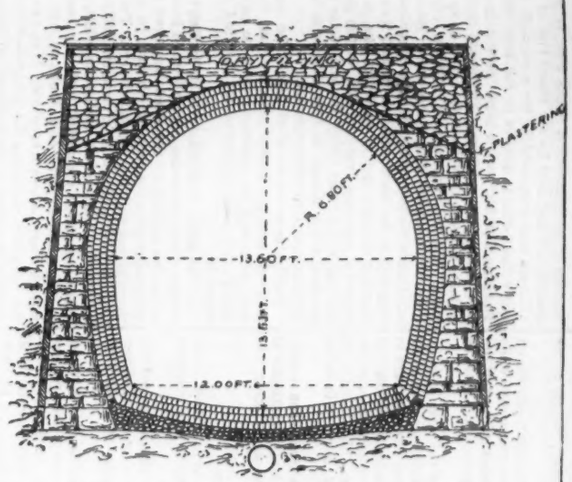
NEW CROTON AQUEDUCT; TYPICAL CROSS-SECTIONS.



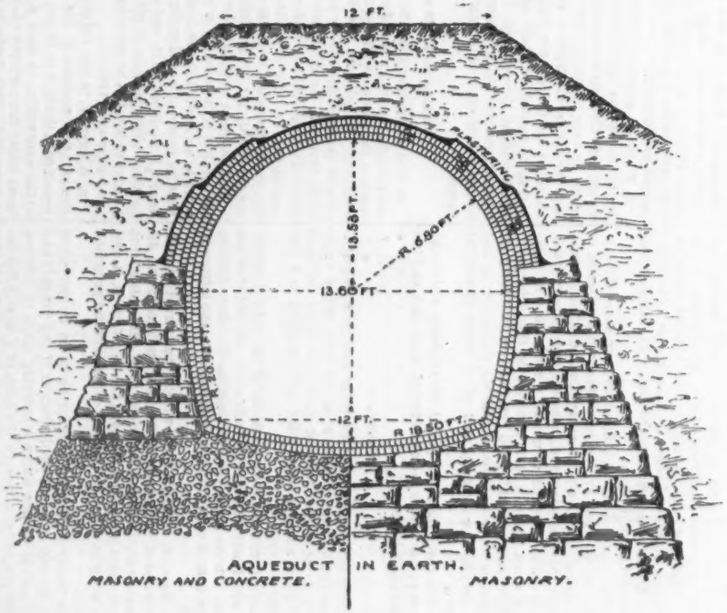
TUNNEL EXCAVATION & MASONRY.
EARTH — SOFT ROCK



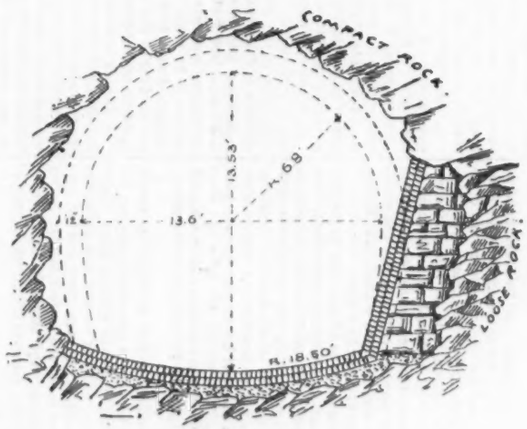
AQUEDUCT IN ROCK TUNNEL.
WITH ROOF ARCH.



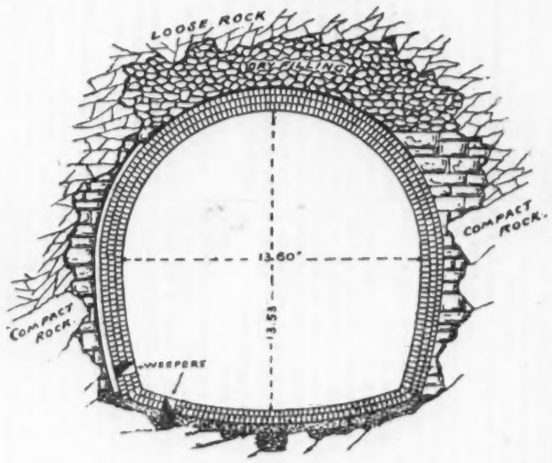
AQUEDUCT IN TUNNEL REQUIRING SUPPORT.



AQUEDUCT IN EARTH.
MASONRY AND CONCRETE. — MASONRY.



AQUEDUCT IN ROCK TUNNEL.



AQUEDUCT IN COMPACT AND LOOSE ROCK.

General Scale. 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 feet

refilling or embankment at an even height on both sides of the masonry, to avoid undue strain on the same. No earth embankment, or refilling, shall be made while there is sufficient frost to prevent perfect work.

9g. The prices herein stipulated to be paid for rock or earth excavation, in open trench, are to cover the cost of sheeting, bracing, and other supports; the cost of pumping, draining, ditching, of maintaining and refilling the trenches, of making the embankments, of disposing of all the materials as ordered, and all other expenses incidental to this class of work.

9h. If the material from the work is not sufficient in volume, or suitable in quality, to build the embankments or to refill the trenches, suitable earth is to be furnished by the contractor and placed in the work, and the price herein stipulated to be paid for borrowed earth is to cover the cost of procuring said earth, of transporting it from the borrow pit to the work, and of disposing of it as directed by the engineer.

SHAFTS.

10. The contractor is to sink one shaft at the points and to the depths directed by the engineer; these shafts are indicated on plan sheets Nos. 2¼, 3¼ and 15. All shafts will have their longest horizontal dimensions parallel with the axis of the aqueduct.

The position of the shafts may be altered by the commissioners within the area of the shaft sites on the line of the tunnel before the inception of the work; and if, during its progress, additional shafts are ordered by the commissioners, such shafts shall be made in the same manner, of the same size, and paid for at the same rate as the shafts mentioned in the specifications and shown on the plans.

11. The supports of the shafts must be so arranged as to leave ample room for all the necessary water, steam, air, and other pipes, and for the convenient use of instruments and appliances for the alignment of the tunnel. Their horizontal section is to be 17 feet 6 inches, by 8 feet in the clear of all rock and of all framing or other supports except, the necessary cross-bracing used for maintaining the sides of the shafts; but where only one heading is worked from a shaft, the dimensions may be changed to 11 feet by 8 feet.

12. The shaft excavation is to be paid for by the vertical linear foot of shaft excavated and completed. The price herein stipulated to be paid for shaft excavation is to cover the cost of all curbing or other support, of all pumping and bailing, and of all work of whatever nature incidental to the excavation and maintenance of the shafts. The number of linear feet in each shaft is to be measured on its center line, from the point where said center line strikes the surface of the ground, to the point where it strikes the soffit of the tunnel excavation.

13. The curbing, whenever any is found necessary, must be of such a nature as to thoroughly support the sides of the shaft, and to secure vertical faces. Cages must be used for the hoisting of men and materials during the construction of the aqueduct, and full precautions must be used to ensure perfect safety. Safety catches of tested efficiency and strength must be used in connection with the cages, to hold them in case of accident.

14. All masonry work in connection with the shafts is to be done as may be directed from time to time by the Chief Engineer. The shafts are to contain masonry into which steps, and other iron pieces are to be built; arches are to be thrown across them, with suitable abutments on the solid rock.

15. The shafts shall be refilled, over or about the masonry, as directed by the engineer, with material of approved quality, from the excavation; the filling material to be carefully lowered, unless otherwise permitted. All the filling must be thoroughly compacted by ramming. Such filling is to be paid for by the cubic yard, and the price per cubic yard herein stipulated for shaft filling is to cover the cost of loading, transporting and and placing the material, and of all work incidental thereto.

16. Wherever there is a portal, the engineer will designate the place where the open trench shall end, and the tunnel shall begin.

TUNNEL.

17. The form and area of the cross-section of the tunnel excavation at any place shall be such as the engineer may determine for that place; but at all points it shall have an area of at least two hundred and one square feet (201).

Various forms of cross-sections of the tunnel excavation are illustrated on sheets Nos. 8¼, 9¼ and 16 of the plans. On the plans, the line limiting the cross-section of the tunnel excavation is designated by the letters *A, A, A.*

18. Masonry shall be built within the tunnel at such points and of such materials and of such form and dimensions as the Chief Engineer may determine from time to time (see sheets Nos. 6¼, 7¼, 8¼, 17, 18, 20, 21, and 24 of the plans for illustrations of some of the proposed forms).

The lower part of the excavation is to be protected with masonry for the whole length of the tunnel; and at all points (except where a circular form is ordered for the masonry) a floor, in the form of a nearly flat inverted arch, is to be built. Where no side-wall masonry is built, skew backs must be cut in the rock for the invert to abut against, as shown on sheet No. 8¼ of the plans.

19. Weepers, of the form and dimension shown on sheets No. 7½ and 21, are to be built in the side walls and floor. No deductions in the measurement of the masonry will be made for the weepers, which must be built true and smooth.

20. The spaces between the top of the arch and the rock or other material of the excavation, or any other space which may be designated by the engineer, are to be filled, at the expense of the contractor, with material excavated from the tunnel, of approved size and quality, and free from all perishable matter. The filling to be carefully and thoroughly compacted, so as to bring an uniform pressure on the masonry.

The extrados of all portions of the arch, when in contact with this filling, is to be covered, at the expense of the contractor, with a coating of cement mortar, not less than one-half inch thick.

TUNNEL EXCAVATION.

21. The tunnel, at any place, is to be excavated to the line of the cross-section determined by the engineer for that place.

No payment will be made for any excavation outside of the cross-section of the tunnel excavation determined by the engineer; but all loose or shaky rock must be removed.

The price per cubic yard, stipulated herein for tunnel excavation, is to cover all expense due to the presence of quicksand or other soft material, rotten rock boulders, etc.; the cost of all pumping and bailing; of all timbering and removal of same; of removing all excavated materials; of all ventilation; and of all other work incident to the excavation of the tunnel. Any expense that may arise from loose and shaky rock, or from falls or caveins, or from unexpected obstacles, shall be borne by the contractor.

22. The engineer may order, at any time, additional excavations for the chambers in the shafts, for the skewbacks of arches, for the sump holes, or for any other purpose in the tunnel or shafts; and the contractor is to do such excavation, which is to be measured according to the lines of the cross-sections determined by the engineer, and paid for by the cubic yard as tunnel excavation.

23. If after the excavation has been made of a certain size by direction of the engineer, he is of opinion that the nature of the rock or other material is such that the form and dimensions of the masonry for which said excavation was intended must be increased, he may order an enlargement of the excavation for the purpose of building masonry of greater thickness, and the contractor is to make such enlargement, which is to be measured according to the lines given by the engineer, and paid for at the price per cubic yard herein stipulated for tunnel excavation.

24. In rock excavation, the drilling and blasting must be conducted with all possible care, so as not to shatter the roof and sides of the tunnel outside of the lines determined by the engineer; and in soft material precautions must be taken not to allow cavities to be formed behind the timbering or other supports; and especially in the vicinity of the existing Croton Aqueduct the blasting and timbering, and any other operation connected with the work, must be so regulated as not to cause injury to said aqueduct. The contractor is to be held responsible for all injuries to the said aqueduct caused by his work.

25. If, in the opinion of the engineer, the contractor, by the use of too high explosives, bad location of drill holes, defective arrangement of timbers or other supports, or want of proper skill and attention, shall excavate the tunnel or shafts to greater dimensions than is required for the proper building of the masonry, the excess of tunnel or shaft area thus formed shall be filled solid, at the expense of the contractor, with such kind of masonry (brick, concrete, or rubble masonry, as herein specified, or other material) as the engineer may direct.

TIMBERING, DRAINAGE, POWER, ETC.

26. The contractor shall be responsible for properly supporting the roof and sides of the tunnel, and the sides of the trenches and shafts, with timber, or other supports. If, however, the engineer is of opinion that at any point sufficient or proper supports have not been provided, he may order additional supports, or order them modified or replaced, at the expense of the contractor; and the compliance with such orders by the contractor shall not relieve or release him from his responsibility for the sufficiency of such supports.

27. All timber work is to be removed from the excavation; but if in the opinion of the engineer, any timber work be so located in the tunnel or shafts or trenches, that its removal would endanger the safety of the masonry, it shall be left in, and all cavities about it shall be filled with masonry or with such other material as he may order; but no payment is to be made to the contractor for such timber

28. Wherever, in the opinion of the engineer, special means are necessary for draining the tunnel, or trenches, a drain is to be cut in the rock below the floor of the excavation, to such a depth as to free entirely from water the portions where the masonry of the floor is to be laid. This drain is to be paid for per linear foot of its length, in rock excavation only. If, in the opinion of the engineer, a drain pipe is necessary, it shall be laid and paid for per linear foot of its length. All drain pipe furnished for the work shall be vitrified sewer pipe, equal in quality to the best "Akron" pipe. The pipe must be "socket pipe," perfect in shape, and free from cracks and flaws. The joints must be made tight, to prevent gravel and sand from passing through them. If in the opinion of the engineer it be necessary, they shall be caulked with neat cement. No size is fixed, in advance, for the drains; but the contractor is to be responsible for their sufficiency; and if the engineer find that they are not of sufficient size to drain the tunnel or trenches properly, and for the protection of the masonry, he may order the contractor to increase the means of drainage; and the contractor is to do so without any extra compensation.

The drains are to be filled, before the completion of the work, with the kind of masonry that the engineer may order; and the contractor is to be paid for such filling at the price stipulated for the kind of masonry ordered.

29. The power to be employed in driving the tunnel—except when otherwise allowed—shall be compressed air, to be applied by the most approved method; or some more effective force which shall be approved by the engineer and the commissioners. The contractor is to use such appliances for pumping, drilling, blasting, ventilating, hauling or hoisting materials, and for all other operations connected with the excavation and support of the tunnel and shafts, as will secure the rate of progress herein specified. If at any time before the inception, or during the progress of the work, such appliances appear to the engineer, to be inefficient, or inappropriate, for securing the quality of the work required, or the said rate of progress, he may order the contractor to increase their efficiency, or to improve their character, and the contractor must conform to such order; but the failure of the engineer to demand such increase of efficiency or improvement shall not relieve the contractor from his obligation to secure the rate of progress established in these specifications. The tunnel must be kept so free from smoke and noxious gases that the engineer or his assistants can, when necessary, establish the alignment, or do other engineering work, efficiently.

AQUEDUCT IN OPEN TRENCH.

29a. The Aqueduct and other structures, where built in open trenches, shall be built of the class of masonry, and of the form and dimensions that may from time to time be designated by the Chief Engineer. Sheets Nos. 19, 22, 23 and 25, of the plans illustrate some of the forms proposed for the Aqueduct in open trenches.

29b. The engineer may order timber platforms to be placed under the masonry of the Aqueduct in open trenches, and the contractor must conform to his directions in regard to the size, form and manner of placing of said platforms. Their general character is illustrated on sheet No. 19 of the plans.

29c. Whenever piles are ordered to be driven to support the platforms, they shall be driven in the position and manner, and to the depths ordered by the engineer; and if driven in a wrong location, or injured in any way by driving, they must be withdrawn and replaced by others.

All piles are to be straight, sound, spruce sticks, measuring at least 10 inches in diameter 3 feet from the butt, and not less than 6 inches at the small end. After being driven their upper end must be sawn to a true plane for proper adjustment with the capping timbers. The price herein stipulated to be paid, per lineal foot of pile, is to cover the cost of furnishing, driving, and preparing the piles ready for the capping timbers.

29d. The piles are to be capped with 10 x 10 spruce timber, notched two inches on each pile, and fastened to the same with oak treenails not less than 18 inches long and one inch in diameter, one to each pile.

On the caps are to be placed one or more layers of timber, planks, or boards, of the size shown on the plan to be furnished from time to time.

All timber must be fastened by spikes, of approved number and size. Care shall be taken to make close joints in order to prevent water from interfering with the laying and setting of the masonry placed on the platforms; and whenever two or more thicknesses of lumber are ordered, they shall be placed so as to cross joints.

Wherever timber platforms are placed in the trenches the grade of the bottom of the trenches shall be the grade of the under side of the lowest horizontal timbers.

All lumber used in the platforms is to be spruce of first quality, and free from all defects which may impair its strength and durability.

No wastage is to be allowed for, and the estimate of quantities of timber used will be based on the amount ordered by the engineer and placed according to his directions.

TO BE CONTINUED.

"ENGINEERING Drawings and Data of the New Croton Aqueduct" contains very nearly all that is to be found in the Fifteen Dollar copy of the Aqueduct Commission. The price is $2.00.

Railroad Statistics of the World.

The total length of railroads in operation at the close of the year 1883 was 442,199 kilometres, or about 275,000 miles. Of these, 114,000 were in America, 11,500 in Asia, 3,500 in Africa 6,500 in Australia, New Zealand, etc. The increase in the four years 1880-83, has been 57,000 miles an increase 26 per cent over the mileage in operation at the close of the year 1879. The most rapid percentage of growth is shown in Mexico, which in 1879 had less than 700 miles in operation at the close of the year 1879 miles an addition of 335 per cent, The increase in America as a whole has been 41 per cent, that of Australia has been 52, that of Asia and Africa each 26, that of Europe only 11. Of the countries of Europe, Germany now has 22,400 miles of railroad an increase in four years of 8 per cent. Great Britain and Ireland, 18,700, increase 5 per cent. France, 18,600, increase 18 per cent. Russia, 15,700, increase 7½ per cent. Austria, 22,900, increase 12 per cent. The United States has a mileage of nearly 120,000 (or decidedly more than the whole of Europe), having increased 42 per cent. in four years. For every 100 square miles of territory Belgium has 24½ miles of railroad, (or not far from the proportion in Massachusetts, Connecticut, or New Jersey). On the same basis of comparison, Great Britain has 15½ miles; Holland, Switzerland and Germany each not far from 11; France 9; Denmark, 7½; Austria and Italy a little over 5 each; the whole United States, 3½. When we compare railroads with population, of all the countries in the world Queensland stands highest, with 44½ miles of railroad to every 1,000 inhabitants. On the same basis, New Zealand has 30 miles; New South Wales, 19; Victoria, 17. The United States has 23 miles per 1,000 inhabitants; British America, 18. The only European country which makes a respectable appearance in this table is Sweden, with 8¾ miles. Switzerland has 6 miles (½ mile less then the Argentine Republic),; Denmark, 5⅔; Great Britain, 5½ (about the same as Peru or Chili); Norway, a little over 5. Germany, France and Belgium have each a little less than 5; Holland has not quite 4; Spain about 3 (nearly the same as Mexico or Brazil); Italy and Russia each about 2 miles.

A Big Blast.

The following account of a blast is taken from a San Francisco paper of Feb. 18. 1885;

Recently the San Francisco Bridge Company received the contract for work on section 6 of the seawall, which will extend from Vallejo to Pacific street, and which will practically continue the seawall from Powell street to Folsom. It became necessary for the Bridge Company to secure a quarry. A tract of eight and one-half acres was obtained, fronting on and extending into the bay, and forming a high bluff which forms the northern extension of Visitation Valley. The bluff is about sixty feet high close to the water's edge. It is expected to yield the 90,000 tons of rock required to build section 6 of the seawall. It has been tunneled recently by employès of the Bridge Company in charge of Superintendent O'Neil. Eleven tunnels in all were run. Four were announced as ready to be exploded yesterday.

At 1.30 o'clock all was in readiness. There were 11,000 pounds of Judson powder to explode in the four tunnels. Each tunnel was fifty feet fong, and extended to an L in which was the powder. From the L to the mouth of each tunnel rock and dirt had been "tamped" in as hard as possible. At about 1.40 o'clock a considerable number of workmen were seen scrambling up the precipice from the vicinity of the openings of the tunnels to the hills back of the cliff. Soon after smoke was seen at the entrance of tunnel No. 1. The four explosions were to occur successively, the first to loosen the cliff and make it easier for the second to become effective, and so on. The first explosion was awaited with some little apprehension by the Harbor Commissioners and other occupants of the tow-boat. But when it occurred. with a dull heavy sound, and it became apparent that fragments of stone were not to fly through the air, there was a unanimous desire that the boat should move nearer the shore. The other explosions occurred soon after. No. 3 was a grand affair. A great section of the cliff was toppled over and huge bowlders and tons of dirt rushed down to the water's edge. The blasts were pronounced successful and the quality of stone, on subsequent inspection, seemed satisfactory to the Harbor Commissioners. It was estimated by the engineers that the 11,000 pounds of explosives had desplaced, in about ten minutes 35,000 tons of rock and earth.

OUR MATHEMATICAL COLUMN.

THREE has been called the mystic number, since it appears so prominently in the poetry and religion of all times and people. Thus we have the three great lights, the sun, the moon and the dog star; and the three lesser lights, the comet, the meteor and the firefly. In the theory of numbers three is distinguished by many properties. For instance, if any two numbers be taken at random, one of them, or their sum, or their difference, is divisible by three.

THE ALMANAC for March is interesting on account of two eclipses, one of the sun on the 16th, and one of the moon on the 30th. The eclipse of the sun will be annular in Northern California, Montana and Idaho, and partial in the United States generally. In the Atlantic States about three-fourths of the sun's disk will be covered, the greatest obscuration occurring about 1.30 P. M. The eclipse of the moon is invisible in the United States. During the month the weather grows warmer, the hens begin to lay, and a decided improvement in business is expected. The planet Jupiter rises early in the evening, and hovers near the blue star Regulus in the constellation Leo.

A SUBSCRIBER writes:—"I am particularly interested in your mathematical column, for I find the problems beget dimensions which are of great benefit. For instance I wish to refer to Problem 2, in your issue of Febuary 7th. The result seems to be correct but it is not quite clear why, after having found the velocity of efflux as 10.1 feet per second, the head 1.6 feet which would cause this velocity is used to multiply into the weight to find the work performed. As the weight is 825 pounds per minute, and the velocity 606 feet per minute, it would seem that the horse power should be

$$H = \frac{825 \times 606}{33{,}000} = 15.5$$

but this is certainly too large, and I presume your solution is correct, but I cannot analyse the problem, and hence write for information."

Our correspondent here confounds work with momentum. The work or energy of a weight W, moving with a velocity v, is $\frac{Wv^2}{2g}$, and this may be written Wh, where h is as the same as $\frac{v^2}{2g}$. In the above case then the horse power is either

$$H = \frac{825 \times 10.1 \times 10.1}{64.4 \times 33{,}000} = 0.04$$

or, having just found the value of h, it is

$$H = \frac{825 \times 1.6}{33{,}000} = 0.04$$

as Mr. Shiraish correctly determined. Other correspondents have also fallen into the error of confusing momemtum with work, in their solutions of Problem 5, below.

THE DETERMINATION of the most probable mean of three discordant observations is still an unsolved mathematical problem. The usual way is to take the average or arithmetical mean. For example, if three measurements of a line gave the values 86, 87 and 97, the most probable mean is taken as their average, or 90. But this evidently regards the measurement as of equal weight, whereas the close agreement between 86 and 87 would lead us to infer that they are more reliable than the third value. Laplace deduced over a century ago a complex rule for finding the mean in such cases, which, however, is not generally accepted as a satisfactory solution. His rule gives the mean for the above case as 88.1, which certainly seems more reasonable than the average value 90

THE TONAL system is the invention of J. W. Nystrom of Philadelphia. It not only reforms arithmetic, but extends to weights, measures, coins, clocks and compasses. The base is sixteen instead of ten, and as five new symbols are needed he thinks it well to give new names to them all. Thus 0 is called Noll, 1 is An, 2 is De, 3 is Ti, 4 is Go, and so on. The new name for 45 will be Sangotonsu, and that of 1000 will be simply Bong. He divides the year into Ton (sixteen) months, called Anuary, Debrian, Timander, Gostus, Suvenary, Bylian, Ratamber, Mesuduis, Nictoary, Columbian, Husamber, Victorius, Lamboary, Polian, Tylander, and Tonborius. Not content with reforming the calendar he gives us a new thermometer, a new musical notation, divides the clock into *ton* equal parts and makes the *tim* hand go around once in a day and night. Nystrom has done his work well.

PROBLEM 4. (Proposed by T. J, L., New York). Let $A\ B\ C$ be the base and D the vertex of a triangular pyramid, all of whose linear dimensions are known. What is the vertical distance of D above the plane of $A\ B\ C$?

Solutions have been received from E. S., Mount Pleasant, Pa., N. Shiraish, Philadelphia, W. W. Follett, Shreveport, La., and J. W. N., Newark, N. J. All of these solutions seem correct, but the following by E. S. is the most practical: From the points A, B and C, draw in the plane $A\ B\ C$ perpendiculars to the sides $A\ B$, $B\ C$ and $C\ A$; these perpendiculars meet in a point S. From the vertex D draw the perpendiculars $D\ E$, $D\ F$ and $D\ G$ meeting the sides of the base in the points E, F and G. Let O be the point in the plane $A\ B\ C$ which is directly under the vertex D. Then if $D\ E$, $D\ F$ and $D\ G$ be drawn, they will be also perpendicular to the sides $A\ B$, $B\ C$ and $C\ A$, and parallel to the three perperdiculars drawn from the points A, B and C. Since the sides of the triangles are all known, their angles are easily computed, and also all of the perpendiculars except those drawn from the point O. These latter perpendiculars, however, are easily found by similar triangles. Then the vertical distance $D\ O$ is determined from the right angled triangle $D\ O\ E$ or from $D\ O\ F$.

PROBLEM 5. A ship weighing 4,500,000 pounds, moving with a velocity of one foot per minute, strikes the gate of a canal lock. The gate can slowly yield under the pressure a distance of six inches, but no more. If the gate can stop the ship find the number of pounds pressure against it.

A large number of solutions have been received, giving results which range from 2,225,000 pounds to 39 pounds. The following solution mostly by N. Shiraish we regard as correct:—This is a case of the transformation of kinetic energy into work. The work done by the gate is $\frac{1}{2}P$, where P is the average pressure in pounds and $\frac{1}{2}$ is the distance in feet through which it is exerted.

The kinetic energy of the ship is $\frac{Wv^2}{2g}$ where W is 4,500,000 pounds, v the velocity in feet per second and g the acceleration of gravity. Equating these we have

$$\tfrac{1}{2}P = \frac{4{,}500{,}000}{2 \times 32.2 \times 60 \times 60}$$

which gives for P the value of 39 pounds. The pressure however is not constantly, but is nothing when the ship first touches the gate and then increases. As the problem does not state the law of increase of the pressure we may regard it as uniformly varying with the distance the gate yields. The pressure against the gate would then be 39 pounds when it had yielded three inches, and 78 pounds when it had yielded six inches.

PROBLEM 6. A triangular pyramid whose base is $A\ B\ C$ and whose vertex is D has the following dimensions: $A\ B = 12$ feet, $B\ C = 13$ feet, $C\ A = 5$ feet, $D\ A = 12.21$ feet, $D\ B = 11.18$ feet, and $D\ C = 10.68$ feet. Required the vertical distance of the vertex D above the plans of $A\ B\ C$.

PROBLEM 7. (Proposed by W. G. W. Montgomery, Ala.) It is required to find the diameter D of a drain by Adam's formula

$$\log D = \frac{2 \log A + \log N = 3.79}{6}$$

when $A = .43$ acres and $N = 480$. The proposer says: "This will probably not trouble professors, but I believe numbers of working engineers will be worried before they arrive at a correct solution."

PROBLEM 8. A roof whose span is 24 feet and whose rise is 5 feet consists of two rafters, each 3 inches wide and 6 inches deep. Find the load per linear foot of rafter which will produce a compressive stress of 600 pounds per square inch at the most dangerous section of the rafter.

THE largest steam hammer in the United States weighs, complete, 340 tons, is thirty-eight feet high and cost $60,000. It was manufactured in Philadelphia and has just been placed in a forge works in Cleveland.

AMONG the new applications of cotton is its use, in part, in the construction of houses, the material employed for this purpose being the refuse, which, when ground up with about an equal amount of straw and asbestos, is converted into a paste, aud this is formed into large slabs or bricks, which acquire, it is said, hardness of stone, and furnish a really valuable building stock.

Engineering News

AND

AMERICAN CONTRACT JOURNAL.

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THE specifications of the New Croton Aqueduct, in this issue, are printed by request of a number of our subscribers. The specifications are given for Section 9 of the Aqueduct, that one being selected as typical of all the others, excepting only Sections "A" and "B" which being under pressure, differ in some of their details.

The illustrations accompanying the specifications are given as *possible* cross-sections, under the varying conditions of the work. They were published by the engineers of the Aqueduct simply as a guide to the contractors in estimating, and may or may not be used in the actual construction.

The typical cross-section of the Aqueduct, on a gradient of seven-tenths feet per mile, is equivalent to the area of a circle 14 feet in diameter. The illustrations show the additional area allowed for friction in the portions of the unlined rock tunnel, and under the other varying conditions of material. On the two sections nearest to the Harlem River, the Aqueduct being under pressure, the areas are correspondingly reduced, in one case to 10½ feet diameter, as shown in ENGINEERING NEWS of Dec. 6, 1884.

The Chestnut St. Bridge Repairs.

THE discussion now going on in the Engineers Club of Phila., regarding the Chestnut St. Bridge repairs is interesting. One party claims that the west river abutment has moved shoreward and the column struts were put in to arrest this movement. The other side deny any movement in this main abutment and say, in effect, that the struts should have been turned around against the retaining walls, to which they charge all the mischief.

From the very much mixed available data on the substructure of this bridge it is rather difficult to back up any decided opinion. But we believe that both parties are right, as far as the movement is concerned; in other words, both ends have moved but in opposite directions and from different causes.

A glance at the diagram, in ENGINEERING NEWS of Jan. 3, will show, we think, that the line of thrust from the river span arch will strike very near the westward end of the timber grillage under the main abutment, and that it there meets, not a solid material, but lands on the head of piles driven in a soft silt without lateral stability or resisting power. These being the conditions it is natural to expect that the abutment has slid westward to an extent due to the tilting in that direction of the piles under the arch thrust *continued*. If the west abutment has moved we would expect to find a settlement in the crown of the river arch and a corresponding shortening of the upper member of the arch system. Now there *is* an opening of several inches between the iron cornice of the bridge and the stone coping of the abutment, and cast-iron sleeves have been put in place to hide this opening above.

The retaining walls have very evidently bulged outwardly and settled down vertically, and the abutment connecting the river ends of these walls is comparatively light. These walls rest upon piles driven into the same soft material, and the pile foundations under the parallel walls are in no wise connected by ties or cross-piling. Hence, when the heavy filling material, used for the approach, was piled in, this filling sank down into the soft under-stratum between the two pile foundations and wedged them apart at the top, and in places the piles sunk vertically. According to an examination, made by the contractors for the late repairs of the retaining wall abutment, the bulge in it does not extend to the foundation; this last is straight in front but droops at both ends, apparently from the failure of the pile foundations there.

The eccentricity in the behavior of the two shore arches is more difficult of explanation; though the one nearest the river has also suffered somewhat, as a slight crack does appear in it near to the key. We imagine that the greater distortion of the west arch is due to a meeting of the thrusts, just at that point, coming from the failing retaining wall on the west and the sliding abutment *and* arch-pier on the east.

We will look with interest for any further data on this question that Prof. Haupt may secure from his fixed transit points, and the careful examination into the general movements of the structure which we understand he is now making.

The Proposed Railroad and Pipe Line from Suakim to Berber.

The article from the pen of Col. H. G. Prout, in the present issue, on the proposed railway and pipe line from Suakim to Berber, is valuable from an engineering point of view as being a record of one of the few surveys ever run over this now interesting route; and, beyond the official report to the Egyptian government, this is the first time an actual profile of the line has ever been published.

The pipe-line, for which the firm of Henry R. Worthington of this city have already the contract to furnish the pumping plant, is a necessary preliminary to the more important railway line that is to follow; for without a water supply assured to the workmen and guards the building of the line would be practically impossible.

The advantages of the Suakim-Berber line as a railway route over the Nile valley scheme, as proposed by Mr. Fowler, of England, are sufficiently pointed out by Col. Prout, and we will not repeat them. The only cause for wonderment is, that the railway has not been built before this on the shortest line. A Winnipeg contractor has cabled a proposition to finish the 260 miles in five months; and with water and a sufficient guard provided, we have no doubt he can do it. A comparatively small portion of the treasure and human life wasted on the Wolseley advance on Khartoum, by way of the Nile and its cataracts, would have footed the bill for the railway from Suakim to Berber; and with a railroad built and maintained to the Nile at Berber, the problem of beating El Madhi would be well nigh solved.

The Messrs. Worthington say that the proposed water supply is to be secured by laying two lines of 4 inch mains, and pumping stations at intervals of 25 or 30 miles along the route. At each station will be two pumping engines, capable of forcing water under a pressure of 200 lbs. to the square inch. Water will be delivered at the end of the route at the rate of about 150 gallons per minute. It is proposed to lay the pipe in zig-zag lines in the sand to allow for expansion in the metal.

In connection with this modern pipe-line across the desert, Mr. F. Cope Whitehouse, the well-known student of Egyptian topography and antiquities, says, in a recent interview, that the project is not so very novel after all; that the ancient Arabians supplied wells in the desert by water conveyed in leather mains more than 3000 years ago. Herodotus is his authority, and that ancient author says that the Shepherd Kings made pipes of the skins of oxen and other animals, and by three distinct lines carried water a 12 days journey, about 200 miles, from a river to cisterns in an arid tract of Arabia.

Report, New York Board of Public Works.

According to the report of the Commissioner of Public Works, of New York, for the quarter year ending Dec. 31, 1884, the total expenditure for the quarter was $1,515,314.51. Fifty-five contracts, amounting to $553,503.03, were entered into, and seventy-five, at $1.143,803.37 were finished, completed during the quarter.

The Chief Engineer of the Croton Aqueduct reports that during October, 860,000,000 gallons of water were drawn from the two storage reservoirs and the various lakes in the Croton water-shed. The rainfall for the year 1884 at the several rain-gauge stations was:

	INCHES.
At Boyd's Corner Reservoir, Croton water-shed	53.71
At South East Reservoir, Croton water-shed	50.15
At Croton Dam, Croton water-shed	59.94
At Kensico Reservoir, on Bronx river	52.56
At Central Park Reservoir	50.96

The records of the rainfall at Boyd's Corner Reservoir, in Putnam County, extend back to the year 1866, and show that during that time the rain-fall of last year was exceeded only in 1878 and 1882. Notwithstanding this large quantity of rain for the whole year, there were several protracted periods of extremely dry weather, when the natural flow of the Croton river fell far below the quantity required to keep the Aqueduct supplied to its full capacity and it became necessary to draw water from the storage reservoirs and lakes to supply the deficiency. The total quantity of water so drawn is 2,040,000,000 gallons, of which 1,590,000,000 gallons were furnished by the two reservoirs, or artificial lakes, and 450,000,000 gallons by Lakes Mahopac, Kirk, Gilead and Gleneida. All the reservoirs and lakes are now full.

The total distribution system of the city now includes 562⅞ miles of pipes, 5,960 stop-cocks and 7,400 fire-hydrants. Of these pipes 14¼ miles were laid in the last year, mostly 12 and 6 inch, together with 248 fire-hydrants and 270 stop-cocks.

In detecting and checking the waste of water, 192,277 house inspections were made, detecting 5,944 wastes, due defective plumbing, and 272 places where faucets were kept open. The department also made 9,275 night examinations of house-drains, to find places where water is allowed to run at night; 940 such places were

discovered, with a flow of water into the sewers of from one to five gallons per minute. The one great source of waste, which it is impossible to stop with the present means and authority, is the wasting of water to prevent freezing in the pipes in cold weather. As showing the enormous extent of this waste, on Dec. 20, a very cold day, the water in the Central Park Reservoir was drawn down 5 in., a waste of 13,000,000 gallons over the usual daily consumption and over the supply received through the Aqueduct.

During the last year, 2,613 additional water-meters were put in, making 11,625 water-meters used in the city to Dec. 31, 1884. The quantity of water supplied through 10,905 meters, on which one or more readings have been taken is shown in the following table:

	No. of Meters	Gallons per diem.
Hotels	343	1,706,100
Breweries, bottlers, etc.	318	1,583,600
Charitable institutions	97	411,000
Office buildings	1,785	1,670,000
Factories	671	1,916,400
Gas-works	38	824,400
Railroads	198	1,230,000
Stables	1,575	1,038,600
Apartment-houses	117	255,000
Docks	111	1,415,300
Miscellaneous	5,652	7,896,200
Totals	10,905	20,006,600

The Revenue from water supplied through meters, during the year is $680,060.98.

By a decision or judgment of the Court of Appeals, the city has become the owner of 10,000 "Navarro" water-meters, ordered by the Department under the administration of Commissioner William M. Tweed, but rejected by his successors on the ground that the price agreed to be paid for them was exorbitant: 4,050 of them have been tested and regulated to measure the water passing through them accurately, but all these meters have been stored for so long a time (about fourteen years) that they will require certain necessary repairs before they can be used. It is suggested by the Chief Engineer of the Croton Aqueduct that these meters be placed on houses used exclusively as dwellings, where under the law, meters cannot be placed at the expense of the owners, and where waste of water is known or believed to exist; and he thinks that the cost of the meters, putting them in order and setting them would be returned to the city in one year by increased revenue for water measured by them.

The present area and length of paved streets under the care of this Department, exclusive of the streets north of Harlem river, which are under the care of the Department of Public Parks, is as follows:

	MILES	SQ. YDS.
Granite-block pavement	62.53	5,000,000
Trap-block pavement	232	
Cobble pavement	37.81	655 000
Macadam pavement	27.60	958.600
Ashphaltum pavement	.62	8,800
Totals	360.59	7,422,400

As showing one of the difficulties of keeping these streets, etc., in proper condition the following list is given of private sub-way excavations and railway-building within the year.

65¾ miles of gas-mains laid.

13 1/10 miles of double track railway built.

3 1/10 miles of underground telegraph and telephone wires and tubes laid.

1,068 linear feet of steam-pipes laid.

6,448 linear feet of pipes laid for using salt water.

In addition to these main lines of pipes, tubes, wires, etc., the several companies made 12,231 excavations in the streets to connect with houses and repair connections.

The aggregate length of new sewers built under the several contracts in 1884, is 4 4/10 miles, with 46 receiving-basins.

The sewerage and drainage north of the Harlem river, in the Twenty-third and Twenty-fourth Wards, is under the control of the Department of Public Parks. The sewerage system south of the Harlem river, under the charge of this Department, on Dec. 31, 1884, included 411 4/10 miles of sewers and culverts, and 5,010 receiving-basins.

The report of the Superintendent of Lamps and Gas shows the names of the new streets, having an aggregate length of 8¼ miles, on which public gas-lamps were erected and lighted during the year, and also the names of the streets and places to which the electric-light has been extended.

The number of gas-lamps so erected and lighted is 665, and of electric-lights 519. As the 519 electric lights displace about 2420 gas lamps, the aggregate number of lamps is diminished. The total number of gas-lamps in use on December 31, 1884, was 22,923, and electric-lights 647, lighting 443 miles of streets, nearly 2 miles of piers, 1½ miles of bridges, 61 acres of parks and 3¼ acres of public market-places.

There are now under the streets of the city 960 miles of gas-mains.

The Galveston Harbor Improvements.

From the annual report of Maj. S. M. Mansfield U. S. Eng's to the Chief of Engineers, for 1884, we make the following extracts concerning the improvement of the harbor of Galveston, Texas:

The Chief of Engineers, under date of Oct. 15, 1884, says that on the adopted plan (project of 1874, modified 1884) the amount expended to June 30., 1884, was $1,496,522.21, including $100,00 of Galveston City funds. Of this amount, $980,662.51 was applied to jetty construction, viz: 90 feet on the north side and 22,551 feet on the south side of the entrance prolonged gulfwards. During the year ending in June, 1884, only the $100,000 Galveston funds was applied to work on the South Jetty.

The estimate of 1880, $1.825.813, contemplated the obtaining of a channel across the bar, at least 25 feet deep, conditioned upon annual appropriations of $500,000. These conditions have not been observed by Congress, and as a consequence the work has dragged. But the money already expended, in total, has secured a good channel over the inner bar and a very apparent improvement over the outer bar.

The report of Assistant Engineer H. C. Ripley to Maj. S. M. Mansfield shows the following general results as noted in his annual survey of 1884: The survey extends from the 30 feet depth in the Galveston Channel to the 25 feet contour in the Gulf, and embraces the entire area of the inner and outer bars. On the inner bar he notes an increase of depth of 1 foot during the past year, making a channel depth of 26 feet, and upon the shoal in Galveston channel, where there was but 18¾ feet, in 1883, and 17½ feet, in 1882, there is now a central depth of 21½ feet and a width of 350 feet between the 20 feet contours. This improvment has been and is being effected by building up the inner end of the jetty over which enormous volumes of sand were formerly carried at every flood-tide.

This survey also shows that there has been an advance of the outer bar gulfward: the 12 foot, 18 foot and 29 foot contours having moved northward from the jetty for a distance of 10,000 to 12,000 feet. It was originally intended to prevent this action by the rapid construction of the jetties. Upon the crest of the outer bar but slight changes have occurred during the year; but the depth of 13 feet at mean low tide of the last year has been maintained in the jetty channel. A mid-winter survey showed an increase of 1 foot in the navigable depth of water entirely across the bar, but the drift of sand from the north, under the action of the prevailing winds, quickly fills any depression formed either by increased currents from the bay within or by artificial means. It is absolutely necessary therefore to build the north jetty both to make and preserve a channel to deep water across the bar. This north jetty, as shown on the map accompanying the report, is 16,500 feet long, is on a curve with a radius of 23,000 feet, and is projected from a point opposite the 26 foot depth in the Bolivar channel to the 25 foot contour in the Gulf. As shown, the least distence between jetties is about 6,000 feet and the maximum is about 9,000 feet, roughly scaled. The observation of engineer Ripley on the various side currents and shoals formed by the present south jetty lead him to predict the certain succesful operation of the north jetty when built.

In the same report is described and illustrated a hydraulic excavating machine, devised by Major Mansfield, and intended to remove materials from the bottom of ship channels, rivers and harbors, etc., and thus increase the depth of navigable water. The machine consists of a cluster of water-jet tubes running from a bell-mouthed terminus of a straight pipe connected by suitable flexible hose to a force-pump. This device is suspended from a shear on the stern of a vessel close to the propeller. In operation the vessel is securely anchored by 4 or 6 anchors and the water-jet suspended vertically, and this and the propeller wheel both put into motion; the water-jet detaches and breaks up the material to be removed and the current induced or accelerated by the propeller wheel keeps these particles in suspension until carried off by the natural current. As the obstruction is removed the vessel is gradually moved forward by a proper manipulation of the four anchor cables. As used by Major Mansfield, the rose or nozzle terminating the pipe had in it four 1¼ inch nipple-jets, placed 2 feet apart, and in this way a sweep of 8 feet was obtained for the water-jet. The machine is simple in construction and effective in operation, and it is especially adapted to the removel of bar deposits when the material is to be removed short distances to the pool below, and on exposed ocean bars where ordinary dredging is impossible.

PERSONAL.

W. D. POLHEMUS, for thirteen years the Superintendent of the Lehigh & Susquehanna Division of the Philadelphia & Reading R. R., has resigned, taking effect on March 1.

ALBERT F. D'OENCH, a practical architect and civil and mechanical engineer, has been appointed Chief of the Bureau of Buildings, of New York. He succeeds Mr. Esterbrook, resigned.

JOHN R. MCLEAN, of the Cincinnati *Enquirer*, has been appointed receiver of the Cin. & Eastern R. R. in place of S. Woodward, resigned.

ROBERT A. SHALER, late engineer of bridges and buildings, C. M. & St. P. R. R., has resigned, to accept the position of Engineer and Superintendent with Rust and Coolidge, the well-known firm of engineers and contractors of Chicago, Ill.

A. S. MENOCAL, C. E., in charge of the expedition to survey the route of the proposed Nicaraguan Canal, reports to the Navy Department, under date of San Juan River, Jan. 31, the arrival of his party there on Jan. 22, a camp being established near the junction of the San Juan and Serapiqui Rivers. Some objection was offered by officials of the Costa Rican Government to his making any surveys within Costa Rica without further instructions from the Government.

A special messenger was sent to San Jose for instructions. In the meantime a survey was begun on the left margin of the San Juan River and carried to the other side. Mr. Menocal made a careful examination of that river and its tributaries for several miles above its mouth, which satisfied him of the impossibility of raising the waters of that river for the canal by a dam of that point. Surveys were being pros-

ecuted with encouraging signs of success. The health of the party was good, and every member seemed greatly interested in his duties.

ALBERT FINK, the Railway Pool Commissioner, receives a salary of $25,000 a year. His official title is Commissioner of the Trunk Line Railways. He has been willing to retire from his position for some time and is now growing anxious to do so. He is a widower and has one child, a little daughter. His fondness for her is one of his most conspicuous traits. His wealth has been estimated at $5,000,000, and has not, since he became prominent in connection with the pooling arrangements, been put below $1,000,000. The figure is really about $250,000. MR. FINK has never been a speculator and that is the reason his fortune has not expanded—or vanished. He is an engineer by profession and is the inventor of the Fink truss bridge, which is in extensive use in the South. The royalty from that gave him a good share of his fortune. He is a German by birth and thoroughly German in his tastes, although, strangely enough, he prefers to speak the English language. He is very fond of German opera. He used to enjoy social life, but his mind has been given more and more to figures and railway problems until at last he has thoughts for nothing else.

No man ever did more incessant thinking. His only form of dissipation is smoking.

N. GUILFORD the Vice Commissioner, in charge of the freight department of the railway pools, is given to rural employment, and cultivates to the highest state of perfection a garden at his country place at Yonkers. He is fond of hunting, and last year spent two months in the Adirondacks.

S. F. PIERSON, the Vice Chairman, who manages the passenger department of the pools and draws a salary of $10,000 a year, is the son of a clergyman. His particular sport is fishing. He chartered a yacht and spent a month on the Maine coast last year. He is a skilled whist player and a great story-teller. He made some money in mining investments in Colorado, but lost it again. He has lately written some important articles on railway subjects.

R. T. BRYDON, the Secretary of the passenger department, is the finest-looking man connected with the pools; he comes of a family of artists and has "an eye for the beautiful." He was in the army for three years, and was in the battle of Shiloh. He is a crack billiard-player. He is one of the most widely known and popular men in the railway world.

C. W. BULLEN, the Secretary of the freight department of the pools, at one time composed almost the entire board of officers of the Delaware and Ulster Railroad himself. He managed every department on the road, He is an authority and an extensive writer on railway subjects. He has a fondness for smoking a pipe, and is the owner of several available bowls.—*N. Y. World.*

CITY ENGINEER WIGHTMAN, of Boston, Mass., has been engaged in estimating the cost of the proposed bridge across the Charles River, and also in making plans for the structure. The distance from the extension of West Chester Park to Front street extended is 2157 feet, and an iron bridge 70 feet wide with a 50 foot draw will, it is estimated, cost $416,000, of which amount $208,674 will be required for the iron superstructure, and $149,000 for the masonry. Having in mind the probable extension of the Charles River embankment, Mr. Wightman thinks that the first 200 feet of the bridge should be built upon piles, so that a removal may not be a difficult task when the improvements of the shore by the park commissioners requires a change of the same sort. Beyond this temporary structure, if the engineer's recommendation be followed, the bridge will consist of 21 iron spans laid on stone piers, the spans being of alternate lengths of 75 and 105 feet. Of the entire width of 70 feet, 50 is allotted to the roadway, and the remainder for a 10 foot walk on either side. Steam will be used for opening the passages.

Engineers' Club of Philadelphia.

Record of Regular Meeting, February 21st, 1885.

President J. J. de Kinder in the chair; 23 members and 2 visitors present.

The Secretary presented, for Mr. Henry A. Vezin, a set of diagrams for determining belts and pulleys and shafts, with a description thereof. They were derived from Wieber's Skizzenbuch für den Ingenieur, but modified by Mr. Vezin to suit our units of weight and measure, and their application extended. They present the usual advantages of the graphic method; not only saving the time and mental exertion necessary to calculate by formula, but also presenting a picture of possible and desirable modifications of design.

He also presented similar diagrams for cast iron cogs.

Mr. J. Milton Titlow contributed a paper, illustrated by drawings and photographs, upon the Strengthening of the West Main Abutment of Chestnut Street Bridge, Philadelphia."

The bridge is 42 feet wide, with two cast iron arched river spans of 185 feet each, supported by heavy abutments on the shores; on the west are two segmental brick arched spans, of 60 and 53 feet, to two long retaining walls, holding the earth supporting the roadway.

The whole of this west approach is located upon what was called the river flats, partly occupied by wharves and docks, and resting on piles from 24 to 40 feet in length, driven through a stratum of river mud or silt from 16 to 20 feet in thickness, to the coarse gravel with boulders and cobble-stones lying upon the bed rock.

The masonry was practically completed in 1865, about a year before the cast iron river spans; and any movement of the main abutment, by reason of it maintaining its verticality, transferred a horizontal thrust to and through that part of the approach in the rear, shown by a depression of the river spans, a shortening of and a rising of the crowns of the arches in the rear of the main abutment, and a closing of the joints of the copings on spandrel and retaining walls, as well as pushing back the small approach abutment at the springing line between the retaining wall. This rising of the west arch became very apparent in 1879, when horizontal wooden struts were placed above the platform of foundations for the purpose of taking up and transferring this horizontal thrust to the retaining walls, making them act as buttresses temporarily until a plan could be determined upon, which should be effective in itself.

(Then follows a description of the method of repairs as given in ENGINEERING NEWS, Jan. 3, 1885.)

A double-air compressor, with 10-inch steam and air cylinders, made by Delamater & Co., N. Y., was used.

Prof. Haupt did not wish to appear to criticise adversely the conclusions of the writer, but he felt disappointed that the paper did not contain some data, which would support the theory which led to the use of the piles in their present position. This misconception of the problem arises apparently from a failure to distinguish which of the equal and opposing forces is the action and which the reaction, or which the power and which the resistance. If the damage to the west abutment were caused by the *thrust of the iron arches*, as alleged, then its effect would be first manifested on the abutment pier and the adjoining brick arch, before reaching the extreme or land side of the second masonry arch. The writer states that this wall has been thrust *back*, whilst his measurements show that the span has been *reduced* in some places nearly half a foot, and that the reduction of span is greatest at the springing line near the head walls, and also near the ground. He admits that the main abutment-pier has *not* moved, nor has the one to the west of it, between the two masonry arches, as the eastern span of 60 feet is not affected. The span of the second arch could only be *reduced*, therefore, by its abutment wall moving *forward*.

Prof. Haupt believed that the defects of the bridge resulted from a slight settlement on springing of the piles under the corners of the foundation of the abutment and approach walls, thus reducing the frictional resistance of the masonry on the grillage, and permitting the excessive pressure of the earth filling, especially when saturated with water, to overcome the inertia of the masonry in these walls, and break the bond, which, in some places, was very weak, causing the large cracks in the approaches and the first arch. He suggested that the remedy should have been applied originally at this point by the introduction of screw or disc piles around the outside of the abutment, by which the unit pressure might have been reduced to any desired extent. The present tubes are being made to abut against a part of the foundation which is admittedly rigid, are placed at some 120 feet from the weak point, and in such a direction as to oppose no resistance to this thrust.

There is nothing in the paper relative to the effect produced by the former remedies of heavy sills and ties, nor to show that they were so inefficient as to render this last device a necessity in any position.

Mr. Howard Murphy thought that these "heavy sills" should never have been built. They are, in reality, built-up horizontal struts or columns, connecting the substructures, and were intended to relieve the main abutment of a portion of the horizontal thrust of the west iron river arch, by conveying it to the approach abutment through the intermediate pier. That they would, if brought to firm end bearings, have increased the stability of the structure, which ever way it has a tendency to move there is no doubt, if these were all the conditions to be considered. But the Thirtieth Street Extension of the Pennsylvania Railroad passes under one of the arches. The traffic is entirely freight. The heaviest engines and trains may be frequently stopped and started under the bridge, as these tracks are practically a portion of the yard. The struts were laid but a short distance under the surface. If loose, they did no good. If tight, they afforded a very convenient rigid medium for the transmission to the bridge foundations of every shock and hammer blow incident to heavy railroad traffic. The often observed effect of light machinery upon the masonry of buildings, would seem to indicate that a bridge which could stand this kind of thing without serious rupture was not such a bad bridge, after all.

As to whether or not the original designs for the foundations of Chestnut Street Bridge had been faithfully carried out by the contractor, Mr. Murphy stated that any assumption of careless *supervision* of the contractors was absolutely inadmissable.

He differed with Prof. Haupt as to the easterly or riverward movement of the structure, because there seem to be no cracks or changes which *clearly* show this, and, on general principles, because a pier is not likely to move under the thrust of a short high arch against the thrust of a long, flat arch; and because a failing retaining wall is not likely to bulge, horizontally *towards* the retained material, particularly when tied at its ends by walls returning at right angles to it, and against which latter walls there is a greater thrust of arch, owing to some excess of weight, of the spandrels and parapets, over the earth-filling in the middle. Comparison with the accurate transit points, entirely external to the structure, which Prof. Haupt has located, may, however, reveal changes, in one or more directions, now indeterminable.

HOWARD MURPHY,
Secretary and Treasurer.

Denver Society of Civil Engineers.

At the annual meeting of this society the following were elected officers for the ensuing year: *President*, Prof. P. H. Van Diest; *Vice President*, R. B. Stanton; *Secretary and Treasurer*, E. S. Davis; *Executive Committee*, E. S. Nettleton, E. H. Kellogg and B. H. Smith.

Although the Society at present is small there is considerable interest in the meetings.

The subject of, "Canal Construction for Irrigation Purposes" is at present receiving considerable attention. Very interesting papers on the subject were read at the last meeting by W. H. Graves and J. S. Titcomb. The subject will be continued at the next regular meeting which will be held March 3rd, when E. S. Nettleton will present some notes on the "Duty of Water" and "Best known Methods of Measurement and Distribution". This will be supplemented, by comparative notes of Methods in India, by D. W. Campbell.

The society have not yet published any of its papers which have been read since it was organized in 1882.

Canadian Surveyors.

The Association of Dominion Land Surveyors held its Annual Meeting on the 17th ult. in Ottawa. There were four papers read followed by much interesting and profitable discussion.

The following were elected officers for the ensuing year:

President, O. J. Klotz; *Vice President*, J. P. B. Casgrain; *Secretary and Treasurer*, A. F. Cotton; *Executive Committee*, W. Ogilvie, W. Chipman, P. T. C. Dumais.

As soon as the proceedings are published we hope to be able to reprint one or two of the papers read.

CORRESPONDENCE.

St. Louis Sewer Building.

SEWER COMMISSIONER'S OFFICE, ST. LOUIS, Feb. 24, 1885.

EDITOR ENGINEERING NEWS.—Ordinances to establish 28 sewer districts, and to construct sewers therein, have during this winter been submitted to the Municipal Assembly of this City, nearly all of which have been passed, and the remainder will soon follow. The work will be put under contract during the month of April.

The length and diameter of the sewers will be as follows:

3 × 4'	Brick Sewers	1350 feet.
2½' × 3½'	" "	650 "
2' × 3'	" "	10490 "
18"	Pipe	2380 "
15"	Pipe	210 0 "
12"	Pipe	31850 "
		67780 feet, or 12.83 miles.

The cost is estimated at $145,800, to be assessed against the property in the districts, at an average rate of $1.57 per 100 square feet. The aggregate area drained by these districts will be 315.22 acres. Plans and estimates for additional work are being prepared by the Sewer Department, and a busy season is at hand.

Yours respectfully,
WM. WISE.

Newark's Improved Sewerage.

EDITOR ENGINEERING NEWS.—The City of Newark has recently undertaken to solve a sewerage problem of no small magnitude. The south-eastern part of the town lies at an elevation of only 5 to 25 feet above tide water and slopes off into the "meadows," or salt marshes, which extend three miles south-easterly to Newark Bay. The sewage of this part of the town is discharged upon the meadows and the accumulation of foul matter exposed to the sun has, in the course of time, created a nuisance of the worst description. During the summer a strong stench rises from it and is wafted at times throughout the entire city.

Many plans are proposed for removing the nuisance, the majority of them involving a a system of tide flushing. During the past summer Mr. J. S. Schaeffer, then city surveyor, and an engineer of large experience, presented a plan of relief which so far received the approval of the city authorities that they called in Mr. A. Fteley of New York to examine the plan, and together with Mr. Schaeffer to elaborate it. Their first plan was then submitted to Col. J. W. Adams, of New York, and Mr. Rudolph Hering of Philadelphia, and received their unqualified approval.

Then finally the city decided to carry the plan into execution. Mr. Schaeffer was appointed engineer and superintendent of the new work, specifications were prepared and proposals received (for adv't see ENGINEERING NEWS of Nov. 15th). On Nov. 22nd the proposals were opened. Messrs. B. M. and J. F. Shanley, of Jersey City, proved to be the lowest bidders, their price being a little less than $300,000 for the entire work exclusive of pumping machinery (for totals of all bids see ENGINEERING NEWS of Nov. 29th). Messrs. Shanley were awarded the contract, and are to complete it by January 1st, 1887.

The plan of the work includes 1st. an intercepting sewer to be built along the edge of the meadows and below tide level, into which the present sewers will discharge; 2nd. a pumping station, to be built at the lower end of the intercepting sewer, where the sewage will be raised to a height of several feet above tide level; and 3rd. a conduit to be built across the meadows and 2,000 feet out into Newark Bay, through which the sewage will flow by gravity.

The intercepting sewer will be 2¼ miles long with a fall of 9 feet, and the bottom of the invert will be 13 feet below high tide at the pumping station. Its diameter will be 3 feet, gradually increasing to 6½ feet. At the pumping station will be two settling chambers (only one of them to be used at a time) where much of the solid matter will be deposited. The sewage will be raised by pumps a vertical distance of about 20 feet, and allowed to flow out through the conduit into Newark Bay. The conduit will be of wood, 2¼ miles in length and 5 feet in diameter. It will be laid several feet below the surface of the meadows, and will be practically imperishable.

Seven million gallons of sewage daily, and all rainfall to a depth of ⅜ inch in 24 hours (or 18 million gallons for the district drainage), will be disposed of in this way. Rainfall in excess of ⅜ inch in 24 hours will be discharged into the meadows as at present.

Mr. Fteley's able report to the Committee of the Common Council considers not only the pressing needs of the district draining upon the meadows but also the future requirements of the Passaic River district of the meadows themselves when they shall be reclaimed and built up. The work now under construction is planned with a view to its future extension in accordance with Mr. Fteley's report.

L.

The Proposed Railway in the Soudan.

The military authorities have at length made up their minds, and a standard gauge railway is to be laid from the Red Sea to the Nile. The undertaking of this work will give the Egptian campaign an engineering interest of the first importance. It would be idle to consider now the advantages that would have been gained had the work been undertaken in time, neither will we now discuss the wisdom of adopting so wide a gauge as that of 4 feet 8½ inches for a railway in the construction of which time is of vital importance. But in any case it cannot be said that alternative schemes have not received attention, as the matter was under consideration for many days, during which time the 3 feet 6 inches gauge, metre gauge, 4 feet 8½ inches gauge, and a double line of 16 inches gauge were all definitely settled only to be abandoned at the next sitting. At last the standard gauge party carried their way and the difficult was solved, as far as the preliminary talking was concerned. Before we leave this part of the subject, however, we cannot help pointing out that at the present moment there is in this country a large amount of rolling stock and materials for a line of metre gauge all ready for the Indian State Railways. This would be available at once, and even if additions were wanted, numbers of manufacturers have templates and patterns suitable for this work, and there is probably no class of rolling stock which could be turned out with greater promptness.

The distance from Suakin to Berber, the proposed terminal points of the line, is 245 miles, or about as far as from London to Lancaster. From the Red Sea coast at Suakin for seventy or eighty miles there is a steady rise until an altitude of approximately 2869 feet is reached at Haratri. As the pass here through the hills is narrow and deep, it is probable that the greatest difficulties will present themselves at this point, unless a broad stretch of loose soft sand, which is spoken of, may be found more troublesome to overcome. For a further distance of about seventy miles the country consists of desolate plains broken at intervals by ranges of low hills. The rest of the distance to Berber consists of an open barren plain. Berber is over 1000 feet above sea level, according to the late Colonel Stewart, who surveyed the route and reported on it in 1883. So far the construction of line does not appear to offer any obstacles which railway engineers are not in the habit of contending with. The main difficulty will be that of water supply, but as the works are to be of so substantial a nature, this will not form so important an item in comparison to the total amount of work to be done. There are said to be eleven groups of wells in the total distance, but many of these would be utterly inefficient for engineering work. Whether they can be developed by deeper sinking remains to be seen. The military authorities have, however, determined to be independent of such chances, and have made a contract according to which a 4 inch pipe line is to be laid along the whole route.*

The pumps are to be supplied by the H. R. Worthington Hydraulic Works, of New York, who have achieved such a signal success in the pumping of petroleum through long distances in America. There are to be six double pumps with steam cylinders 18 inch in diameter by 18 inch stroke; the water cylinders will be 5 inch in diameter by 18 inch stroke. The boilers will be supplied by Messrs. Robey and Co. The pumps are to be delivered in London in thirty days from date of order. Messrs. Lucas and Aird have set about the work of gathering material for the railway with their accustomed vigor, and are already drawing supplies from all parts of the country, whilst the necessary staff is to be recruited from various contracts the firm has in hand, both in this country and abroad. Mr. H. B. Terry and Mr. J. Blue are to have principal charge of the work, although two members of the firm also go to Egypt in connection with the business. The Admiralty has been directed to find the necessary vessels for transporting the plant to the spot, and shipments, were to have been made, it was said, this week, both from Hull and London. Each vessel will take a complete equipment for the construction and working of five miles of the line, so that should any mishap occur to one vessel the whole work will not be detained for want of some vital feature. The list made out includes a locomotive and ballast trucks and trollies, one crane, two crabs, pumps, steam boilers, permanent way complete, electric light plant, and all other necessary appliances.

As for the time that will be taken in the construction of the line it is very difficult to make a forecast with any pretence to accuracy at present. The great important and uncertain factor at present is the question of native labor. If that can be obtained easily on the spot a great part of the difficulty will be overcome. In any case the first instalment of plant cannot be landed at Suakin much under a month, and it will doubtless be well into May before the whole of the appliances are on the ground. It is evident therefore that this proposed line can have little influence on the present military situation on the Nile.—*Engineering*, Feb. 20.

* H. G. H. Tarr, of Yonkers, N. Y., has been offered the contract of laying the 300 miles of pipe across the desert to supply water to the English soldiers in the Soudan. He has not decided whether he will accept the contract.

TRACK.*

BY W. B. PARSONS, JR., C. E.
ROADMASTER SUSQUEHANNA DIVISION ERIE R. R.

(*Continued from page 140.*)

A much better style is shown in the Erie stand, Fig. 64. The frame being of cast-iron and the moving parts of wrought, 212 lbs. of the former and 120 lbs. of the latter. All stands should have a broad, firm base, as frequently considerable force is required to throw a switch, and moreover, constant use soon shakes it loose unless it has a good footing. The "boxes" where the "target-rod" or "standard" is held should be clasped by a

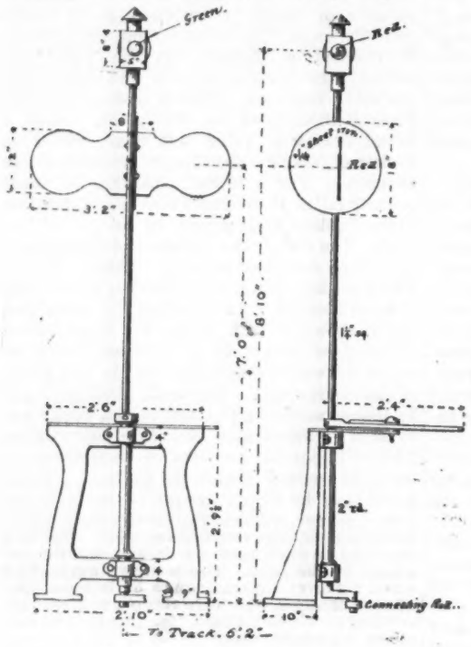

FIG. 64. HIGH SWITCH STAND.

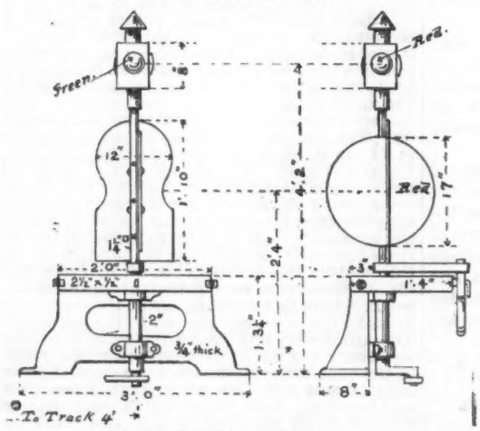

FIG 65. LOW SWITCH STAND.

wrought-iron band so that in case they break they will not fall out of place. The eye of the connecting rod should fit the pin at the bottom of the "standard" without lost motion. For yard work where it is necessary to put the switch stands between the tracks a short form is shown in Fig. 65, in which the cast-iron amounts to 140 lbs. and the wrought to 90 lbs. Even this form at times takes up too much room; or perhaps for unimportant sidings a less expensive style is desired; for which cases the "Tumbling-switch" or "Ground Lever" (Fig. 66) is used, which lies flat on the head block. In winter they have the disadvantage of being covered by snow. Some roads, to obviate the annoyance of the switch stand being shaken loose by the jar, attach the target to a post set in the ground entirely independent of the ties, connected by a rod with the moving rails which are thrown by a tumbling-switch.

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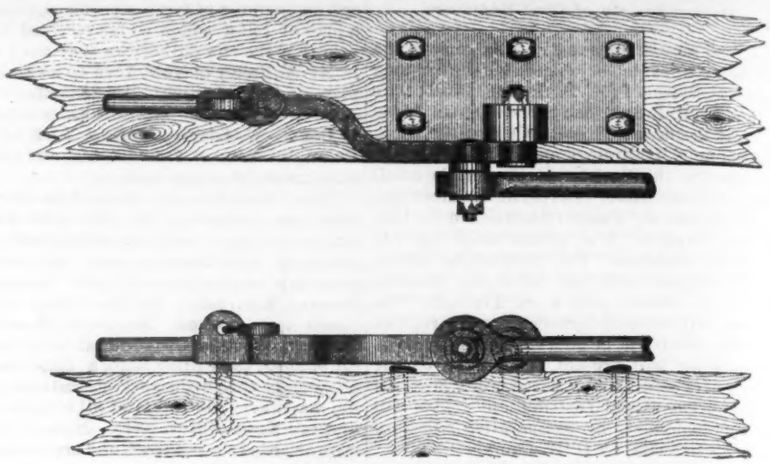

FIG. 66. "GROUND LEVER," OR "TUMBLING" SWITCH STAND.

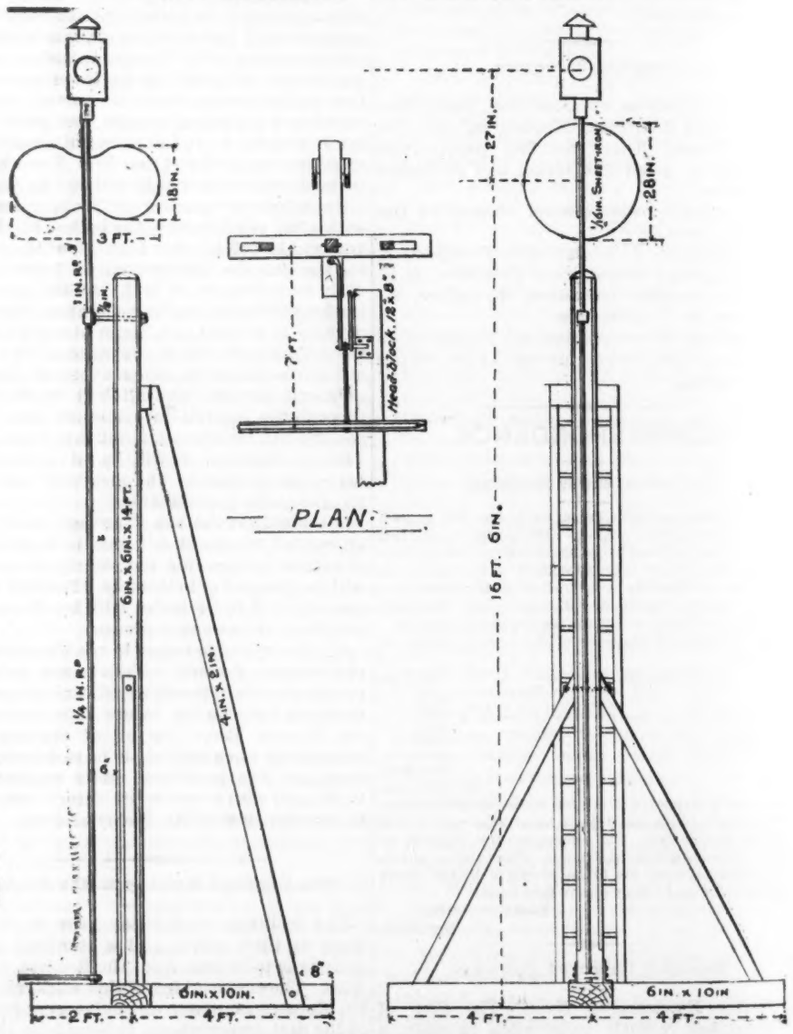

FIG. 67. EXTRA HIGH SWITCH STAND.

This arrangement is frequently used to elevate the switch targets above ordinary obstructions so that they can be seen at a long distance. Such a design is given in Fig. 67. Every switch stand should have a target made of sheet iron to enable the trainmen approaching the switch to see which way it is set. These targets should have two parts at right angles to each other and painted different colors, generally white and red. Signals can be distinguished in three ways; position, shape, and color, where importance is in the order named. If it is possible to see at all, while the color and even the shape of an object may be indistinguishable yet its position can be discerned. On the other hand colors fails to be distinct sooner than shape. With the ordinary switch stands radical change of position of the targets is difficult and expensive to obtain, therefore the shapes of the two parts being thus the most distinguishing features should be made as varied as possible, so that even if the color is obscured by a fog an engineman can tell by the outline of the target whether the switch is set right. In this same connection it is obvious that a perfect uniformity should be preserved over the whole road. The shape of a target admits of an infinite number of designs, many of those seen in common use being very faulty. A very neat shape is shown in the Erie targets Figs. 64 and 65, or the very similar P. R. R. standard Fig. 67. The targets to ensure brightness should be painted every six months, spring and autumn.

(TO BE CONTINUED.)

LITERATURE.

Architectural Perspective for Beginners. Containing eleven Plates of Practical Examples, considered with reference to a student in an Architect's Office. By F. A. WRIGHT, Architect. Wm. T. Comstock, Publisher, New York, 1885, Price $3.00.

The subject matter of this work was originally published in *Building* about a year ago, but has been rewritten, number of new plates added, and the whole issued in a handsomely bound quarto volume. The purpose of the author is to instruct the student of perspective drawing who takes up the study without a mastic. With this expressed intention each stage of the process is plainly explained and illustrated by most excellent plates. The description is progressive passing from the simpler problems to the more intricate and difficult. The illustrations are well selected, capitally drawn and well re-produced, and from excellent studies for even the draughtsman who may consider himself an expert in the more mechanical portions of the work.

"*Tunneling under the Hudson River;* being a Description of the Obstacles Encountered, the Experience Gained, the Success Achieved, and the Plans finally adopted for Rapid and Economical Prosecution of the Work." By S. D. V. BURR, A. M. Illustrated by Working Drawings of all Details; 27 Plates. John Wiley & Sons, Publishers, New York, 1885. Price, $2.50.

We are glad to at last see this important and unique piece of engineering properly and fully described, and the details of its construction and the interesting story of its many trials and partial success recorded in book form. Mr. Burr is particularly well adapted to be its author; almost from the very beginning of active work he was a constant visitor at the tunnel, and, as one of the editors of this journal and a contributor to other technical papers, his notes of progress were carefully and intelligently taken.

With the data thus personally obtained and full access to the detail plans and note-books of the engineers of Col. D. C. Haskin, the Manager of the Hudson River Tunnel Railroad Co., the record is very complete and the resulting work is a most desirable addition to the engineering literature of the day.

The system of tunneling, by the aid of compressed air used in a nearly horizontal shell, here first practically applied on a large scale, is in itself well worth a detailed description. Many engineers of undoubted ability and experience were for a long time dubious as to its success in a tunnel of the dimensions of that under the Hudson River. And though the project now lies dormant from the want of a sufficient financial backing, the progress already made and the many auxiliary devices called forth by the novelty of the situation and the changing conditions warrant the careful study and record which the author has given there in the present volume.

Mr. Burr has plainly but concisely used about all the material that a careful observer, at the tunnel heading itself, could pick up, and this data, used in connection with the illustrations and all the whole story, from its first conception, through its sad accident and the means taken to repair the damages, down to the, it is hoped, temporary abandonment of the work. As the notes were taken at the time and on the spot, and much of the matter was elaborated while all the incidents were still alive with interest, his text is vigorous and furnishes interesting as well as profitable reading

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E. : M. INST. C. E

Continued from page 141.

DCCXXX. INDEPENDENCE, MO.

Independence Missouri, in lat. 39° 5′ N., long. 94° 30′ W. the county seat of Jackson Co., is on the Missouri River in a rich, agricultural district at an elevation of 1,075 feet above the sea. It was settled in 1827, and was for many years the headquarters of the overland routes to Oregon, California and New Mexico.

Water-works were built in 1884, by a private company after plans of P. B. Perkins, taking the supply from the Missouri River. The water is pumped from the river by a Perkins pump of 18 inch steam and 10 inch water cylinders and 24 inch stroke to a settling reservoir 30 feet above the ordinary stage of the river, 195 feet long, 90 feet wide and 13 feet deep, and passes through a filter, consisting of two walls of dry masonry 13 feet high, placed 6 feet apart with the intervening space filled with drift sand, to a storage reservoir 200 feet long, 90 feet wide and 13 feet deep, and is thence pumped by a pump, similar to the one described, lifting 390 feet to another storage reservoir in the city 122 feet long, 87 feet wide and 11 feet deep and 5 feet above the highest parts of the city. All of the above reservoirs are constructed in earth embankment 12 feet wide at the top and 30 feet at the base, the inner slopes being puddled and lined with brick laid in cement, and the bottom with concrete. From the last described reservoir the water is pumped by two Perkins pumps of 15 inch steam and 11 inch water cylinders and 20 inch stroke, to a tank holding 60,000 gallons and raised 73 feet above the highest portions of the city. For fire purposes the pumps deliver directly into the mains.

Distribution is by 8.5 miles of cast-iron pipe, with 50 fire hydrants and 200 taps. Service pipes are of lead and wrought-iron.

The city pays $80 yearly, for the use of each hydrant. No meters are in use. The daily consumption is 250,000 gallons. The population in 1880 was, 3,146 and is now said to be 5,000. The works have cost $90,000.

The bonded debt is $50,000 at 7 per cent. The yearly expenses of maintenance are, $2,500 and the receipts $8,000. P. B. Perkins is Manager of the works.

WATER.

CANTON, Mass., is agitating the construction of water-works.

ELLAVILLE, GEORGIA, has subscribed $800 towards drilling an artesian well.

BOSTON, MASS., is to expend $200,000 in the extensions of its water-mains, service-pipes, etc.

PIERRE, DAKOTA, is to have a $65,000 water-works, the contract being let to Mr. W. W. Walker.

THE ground near Bird Island, Minn., was lately found frozen to a depth of 6 feet below the surface.

THE Council of Wausau, Wis., let a contract to the Holly Company to construct water-works to cost $110,000.

THE Waynesboro, Ga., artesian well has been abandoned. No water within any reasonable distance is the reason given.

BILLS are before the Maine Legislature to incorporate the Long Pond Water Co., and the Waterville Water Co. Both voted "ought to pass.

THE Tenn. Legislature has authorized the City of Nashville to issue $1,000,000 of bonds, $200,000 for the new bridge, $200,000 for the new water-works, $100,000 for sewers and $500,000 to meet bonds now due.

AT a meeting of citizens of West Point, Neb., held lately, it was decided that the town should have water-works costing not to exceed $20,000, and that twenty year bonds, bearing interest of not more than 7 per cent. be issued to pay for them.

THE city council of Gardiner has voted to make a hydrant contract with the Gardiner Water Works company at $50 per hydrant. This insures the construction of the works. There were only two votes against the measures, in the council.

THE Watertown, Mass. Water Supply Co., expect, in a few weeks, to have the system in readiness for general use. The 400,000 gallon reservoir is being filled and the distribution system is being cleaned of the mud and gravel collected in the pipes. About 200 families are already supplied.

DURING December the average daily consumption of water in Duluth was 239,856 gallons, a monthly consumption of 7,373,552 gallons. During the year 1884, the pumps ran, 3,946 hours, consumed 579 tons of coal, and pumped 105,580,208 gallons. The pumps are two of Geo. F. Blake's duplex compound, of one million gallons capacity each.

THE Lookout Water Co. has made a proposition to Chattanooga, Tenn., to lay 12,000 feet of pipe to supply the portions of the town now unprotected from fire, provided the city erects 12 fire plugs. The water department is out of funds and it is not likely the proposition will be accepted.

THE contract for trenching and laying water pipes for the Willimantic Water-Works was awarded February 26, 1885, to James J. Newman of Providence, R. I. Prices bid as follows:

Pipe, per lineal foot: 14 in. 35cts., 12 in. 35cts., 10 in. 32cts., 8 in 25cts., 6 in. 22 cts., 4 in. 20cts.

Setting Valves: 14 in. $2.50; 12 in. $2.00; 10 in. $1.50; 8 in. $1.00; 6 in. 50cts., 4 in. 50cts.

Setting check valves each, $2.50; Setting Hydrants and Steam pipes, $2.50; Rock excavation per cubic yard, $3.00; Mortar masonry, $3.00; Dry masonry, $2.00;

Amount, for quantities as estimated, $19,334.77.

THE Boston Water Board has rescinded its resolution of Jan. 28th, relating to increased water rates and has returned to the old figures of last year. This action is taken in conformity with the request of the Board of Aldermen, but the Water Board represent that it is not in accordance with their judgment, or in the spirit of the original law providing that the water department shall be self sustaining.

A SEWERAGE FOR MANKATO.—The City of Mankato, Minn., has long been discussing the feasibility and adoption of some more perfect system for the disposal of the sewage of that city, upon which work will undoubtedly be commenced next spring. Mr. Chas. F. Loweth, Sanitary Engineer, of St. Paul, has prepared and submitted extensive plans for this work which will likely be adopted.

DR. CYRUS EDSON lately read a paper on the "Artesian Wells of this City," before the New York County Medical Society. He says many of them are polluted; the best of them containing 30 grains of sewage matter to the gallon of water. This is due the geological formation of the island which forms a natural conduit for carrying surface drainage into wells.

THE present plan, in the proposed rebuilding of the Lake Crib of the Cleveland O., Water-works, is to take down the stone work and rebuild the crib of wood, as being better adapted to withstand the storms and ice. This fact is proven by the experience gained in the repairs of five years ago. The wood then put in to replace the stone is yet intact, while the neighboring masonry is carried away.

A WATER JET.—In the office of the Portland (Ore.) Water Company is a part of a broken ironstone china plate that had happened to fall directly over a joint in a water pipe when thrown into the trench among the dirt. The water escaping from a small leak under strong pressure set some grains of sand rotating and wore three holes through the piece of plate and also cut a hole in the brass union, which finally became so large that the water burst up through the street and the leak was discovered.

THE Toronto, Can., Street Commissioner reports as follows on the history of the street watering department:—"In 1875 the last year in which the work was done under contract, twenty miles of street were watered at a cost of $14,399.71. In 1876, the first year under the new system, forty-three miles of street were watered at a cost of $8,365.56, being a direct saving of $6,034.15, while double the mileage of streets was attended to. In 1877 the cost was $9,137 for 45 miles; 1878, $8,436 for 48 miles; 1879, $8,663.86 for 48 miles, and so on. The report concluded that a saving under the present system of $43,000 has been affected in nine years, while over twice the amount of mileage of streets has been watered."

COL. S. H. LOCKETT, Chief Engineer, reports that orders have been issued to at once begin work at pipe laying on the proposed water-works for the City of Belleville, Ill. The scheme of the works is as follows:—A storage reservoir, of 50,000,000 gallons capacity, made by impounding the waters of Richland Creek near the city; clear water basin; a conduit leading from reservoir to basin; a distributing reservoir of 300,000 gallons capacity; a pumping plant of a combined capacity of 2½ million gallons daily; a water-tower, 54 feet above the pumps and 15 feet diameter and 115 feet high. The distribution system contains 10¾ miles of pipe, ranging from 14 to 4 inch diameter. There will be 100 hydrants and 3 drinking foundations.

THE HOULTON, ME., WATER-WORKS.—Ferris & Halladay, of Jersey City, New Jersey, have been awarded the contract for the construction of a system of Water-works for Houlton, Me., by the Houlton Water Company. The land and retaining dam are to be furnished by the company but everything else is to be furnished and the works constructed by Messrs. Ferris & Halladay for $36,500. The entire cost of the works will be fully $40,000. The water will be free from all sewage and mill refuse, being taken from a point well above the village and forced by steam pumps through nearly five miles of pipe in the principal streets. Thirty-five hydrants are to be provided, of which twenty will be located by the selectmen, and rentals therefore paid by the town, pursuant to votes passed at a recent meeting.

THE waterways of Holland are being utilized for the defense of the country after a fashion peculiarly characteristics of Dutch ingenuity. In time of danger, by opening certain dams and barriers, and flooding various lands, Holland can surround herself by a water-line of sixty miles in length and from five to ten miles wide, effectually blocking all advance from Germany on the east. A few narrow roads, guarded by fortifications, will intersect the inundations, which, though kept shallow to avoid hostile vessels approaching, will conceal numerous deep trenches to prevent the enemy from wading through the stream. In winter, when the waters freeze, the depth of the inundations will be increased, and after the surface has frozen the waters below will be drained off, leaving a thin ice crust ready to give way under the weight of troops, and plunge them into the trenches below.

CLEVELAND, O., is much troubled this winter by the freezing of its water mains. The first mains laid were put from 4 to 4½ feet below the street surface; but since 1870 none were buried less than 5 feet deep, and later, 6 feet, has been recognized as a proper length. The present trouble is with the old pipes lying from 4 to 5 feet beneath the surface; about 10 miles of this being yet in its original position and must be relaid. This winter, frost has entered the ground to a depth of 5 feet 3 inches. In some cases 4 inch mains are frozen. The *Cleveland Herald* puts the cost of having a frozen pipe thawed out at from $35 to $40, including coal and digging.

THAWING FROZEN HYDRANTS.—Last week in this city a steam fire engine, with several men were engaged in thawing out frozen hydrants; it is not every city or town where there is even a steam fire engine, and where there is, the method is an expensive one. We present here an illustration of a simple and comparatively inexpensive apparatus which should be in the possession of every city or town having a public water supply, and where the hydrants are liable to be frozen. Mr. W. C. Stripe, the patentee, is Chief Engineer, and Superintendent of the Keokuk, Ia., Water-works, and Secretary of the American Association of Water-works Superintendents. The apparatus is commended by the officials of the Fire and Water Departments of that city and by the City Engineer.

The mode of operating the apparatus is as follows: Steam is injected to the Hydrant through the Rubber Hose "A" until the ice is dissolved. Steam is then cut off and the Inspirator "C" is operated to eject the water from the Hydrant and inject it to the boiler, or to waste it. A few minutes suffice for a badly frozen hydrant. For further particulars address W. C. Stripe, C. E., Keokuk, Ia.

GARDINER, ME., WATER WORKS.

GARDINER, ME., Feb. 28th, 1885.

EDITOR ENGINEERING NEWS:—It is proposed to construct some water-works here this coming summer. Gardiner is situated on the Kennebec River. Population in 1880, 4,479. The proposition is to take water from the Cobbossee Contu stream at Dam "No 8," and pump into a reservoir on a hill near by, 119 feet above the dam. Said dam is a reservoir dam with no mills upon it. It is situated about one mile from the river and 128 feet higher. So the reservoir will be 247 feet above that river, and will give a head of about 225 feet in the business part of the city. Probably, about eleven miles of pipe will be laid this season, of from 12 to 4 inches diameter. Estimated expense $125,000. The following is a copy of the order which is the basis of the contract with the city. Yours truly,

FREDERIC DANFORTH.

IN COMMON COUNCIL, Feb. 16th, 1885.

ORDERED, the Board of Alderman, concurring. That a Joint Special Committee consisting of three from the Common Council and as many as the Board of Aldermen may join, be appointed to make a contract, with the assistance of the City Solicitor on the part of the city, with the Gardiner Water Company, whereby said Water Company shall agree to furnish and set 50 hydrants for the sum of $50 each per year for 20 years. And said company shall further agree to furnish as aforesaid 10 hydrants at the same rate, and said company shall all agree to furnish as aforesaid all hydrants above 60 up to 75 for the sum of $40 each, and said company shall further agree to furnish as aforesaid all hydrants over 75, that the city may need or require, at the sum of $25 each. And said company shall further agree to furnish water sufficient to flush the sewers on Water street for the sum of $25 per year, and said company shall further agree to furnish water sufficient to sprinkle streets as now for the sum of $25 per year. And further it shall be understood and agreed with said company that the city may employ a competent and experienced engineer to consult with the engineer of said company in the construction of the proposed Water works.

NEWS OF THE WEEK.

Railroads, Bridges and Canals.

North Carolina has forty-three railroads in operation; has more than 2,000 mills; has more than 500 mines; has over 5,000 schools; has 156 newspapers.

Hoosac Tunnel.—Massachusetts has under discussion a plan for the sale of the Hoosac tunnel property to a private corporation.

Cost of a Storm.—Supt. Wade, of the Wabash R. R. system, says a heavy snow storm and bad weather generally makes a difference of $15,000 to $20,000 a day to the road, principally from the loss of business.

A Vermont Railroad.—Efforts are being put forth to revive the project for a railroad from Brattleboro to Wilmington, Vt. Stock to the amount of $17,000 has been subscribed by individuals, and the town of Brattleboro will again be asked to vote $50,000.

Bridges to be Built.—The Ohio legislature has authorized the building of a bridge over Rocky River in Cuyahoga county, to cost $10,000.

The commissioners of Garfield county, Col., advertise for the building of a bridge across Grand River.

A Florida R. R. Let.—A contract has been made to build the railroad from Jessup, Ga., to Hart's Road, on the Florida R. R. & Navigation Co's line. Work is to be be commenced in July. This road forms a direct connection with the East Tenn., Virginia, Georgia and Western lines.

Street Railroad for Montgomery. COLUMBUS, GA February 24.—J. A. Gabowry, superintendent of the Columbus Street railroad, left for Montgomery this morning, where he goes to begin work on the street railroad for that city. The material is being received, and the line will soon be in operation.

The Cincinnati Southern R.R. is said to be contemplating a change of gauge from 5 feet to the standard 4 feet 8½ inches. This change has become a necessity as the time lost in hoisting cars at Cincinnati interferes with the heavy traffic. A similar change is contemplated by the Louisville & Nashville R. R.

Another Railroad in Florida, to be known as the Silver Springs and Gulf Railroad, is to be built from Ocala southwest to Camp Izard, via the west side of Tsala-Apopka Lake, on to Brooksville, thence over the route traveled by DeSoto to Tampa Dr. W. T. Sylvester, of Jacksonville, is President, and Messrs. W. R. Utley, Thomas C. Hodge and Colonel Baldwin, New York capitalists, and Col. Tunno, of Savannah, are named as the incorporators.

The Akron and Fort Wayne Railroad Company, principal office at Tiffin; capital stock $100,000 was incorporated Feb. 24th. The proposed road is to commence at the east line of Mahoning County and to extend to Fort Wayne, Ind. A branch is also to extend to Ashtabula and thence to Buffalo. It is the intention to parallel the Pittsburgh, Fort Wayne and Chicago and the Lake Shore and Michigan Southern Railroads.

The St. John's Cantilever.—The cantilever bridge 479 feet long, has just been completed over the St. John's River, which connects the Colonial and American railway systems and reduces the distance between New York and Halifax by rail to 640 miles. It is expected to greatly reduce the ratio of freight between Philadelphia, New York and Boston and the British provinces, and will revolutionize the fish business of the Gulf of St. Lawrence, the catch being now sent through in refrigerato t of ferriage over the St. John's River has heretofore been $5 a car.

The California Southern.—It is understood that Messrs. Kidder, Peabody & Co., are advancing the money for building the extension of the California Southern to connect with the Atlantic and Pacific, taking as collateral the 6 per cent bonds of the company It is supposed that from $1,500,000 to $2,000,000 will be requirep durtng the year, which will be paid as the bonds are sold. The road is doing well. It earned operating expenses, less taxes, during last year, notwithstanding its impairment by freshets and its lack of connection. Its earnings the first month of this year were $2,100 more than those in Januaty, 1884.

To Lay Track in Egypt.—WINNIPEG, Feb. 20th.—Colonel T. C. Scoble, of this city, has cabled the imperial government, offering to build a military railway from Suakim to Berber, a distance of 260 miles. He guarantees the completion and opening of the road within five months from the signing of the contract. Lord Lansdowne has also cabled the home government advising the acceptance of Colonel Scoble's proposition. If accepted, it is intended to ship 500 laborers from Winnipeg to Suakim at once, via Chicago, New York and the Suez Canal. Scoble has made all arrangements to transport men and material so as to have them on the ground inside of a month. The work will be placed in charge of American and Canadian engineers, whom Colonel Scoble claims will be able to complete the work in half the time usually consumed by British contractors, owing to their knowledge of the machine grader and digger.

Scoble was formerly a brigade major under General Wolseley.

Tunnel Under the East River.—Articles of association incorporating a company to build a tunnel under the East River at Blackwell's Island has been filed in the Secretary of State's office at Albany. The corporate name of the company is the "East River Tunnel Railroad Company." The amount of the capital stock is $2,000,000. The tunnel is to begin at some eligible and convenient point in Ravenswood, Long Island City, in Queens county, thence running by the most feasible route and under the bed of the east channel of the East River to and under Blackwell's Island; thence running under the west channel of the East River by the most feasible route to an eligible and convenient point in the city of New York, on the line of the First Avenue, between Thirty-fourth and Eighty-sixth Streets in said city. The entire line of the tunnel will be through solid gneiss rock. It is intended to have two openings, one on each side of Blackwell's Island. There are to be four shafts from which to run the tunnel as well as for light and ventilation. The distance from shore to shore will be only 2,110 feet. The approaches from each end will about 700 feet long, making the total length of the tunnel 3,510 feet, or a little more than two-thirds of a mile. The tunnel, it is claimed, can be built for one-fifth the cost of a bridge and will be no obstruction to navigation, and can be kept in order at a slight cost compared with maintaining a bridge. The tunnel, it is also claimed, will afford a passage for water and oil pipes and telegraph.

Among the incorporators are Col. Robert Townsend, L. Bradford Prince, ex-Senator Birdsall, James H. Platt David B. Sickles, Edward Holland, William H. Bellamy, William A. Lawrence and E. Platt Stratton.

Electric Elevated Travel.—The Edison Electric Railway Company and the Field Electric Railway Company have been consolidated under the name of the Electric Railway Company of the United States, and the company has put up a fund of $75,000 for testing its apparatus on the Second avenue line of the Manhattan Elevated road in New York. Mr. Edward H. Johnson, President of the Edison Isolated Lightning Company, tells the *Mail and Express* that the Manhattan Company has offered the same privilege to the Daft Company on the Ninth avenue line. The Vanderpoole Company, of Chicago, and certain individual interests are represented, but the whole work of preparation will be confined to the presentation of one motor, and when the operation of trains to our satisfaction is effected, the company will ask the Board of Arbitrators, Sir William Thompson, of Glasgow University, President Roberts, of the Pennsylvania Railway; President Rutter, of the New York Central Railway; President Harris, of the Northern Pacific Railway, and Prof. Cross of the Massachussetts Institute of Technology, to investigate the system. Mr. Johnson said further:

It will cost $20,000 to lay a third rail from Chatham Square to the Harlem River, but the other expenses can not easily be estimated. Every car is to have its motor. Our plan is to take the trucks from one of the Manhattan cars and attach the motor at Mr. Edison's works. When one model is complete we shall fit up as many trucks as we desire for our experiment and put them back underneath the cars to which they belong and begin the test. We do not know what the cost will be, but the locomotives of the Manhattan Company cost about $6,000 each, and we expect that motors for a train of four cars will not cost more than that, and probably not nearly as much. It is our purpose to make the test with a force of 600 volts, but the current has not yet been determined. With a 70 pound steel rail and a force of 600 volts an adequate current may be confidently expected. A man will be required to operate each motor, but it has not yet been decided whether to make a place for him by extending the platform at one end of each car, or give him a position inside. A train will look just as a Manhattan train would at present if detached from its locomotive, for although each motor will weigh nearly a ton, it will not be noticeable when attached to the trucks. Cars can be moved separately or in trains, and they can be controlled more easily with electricity as a motive power than they can with steam. Mr. Johnson said they hoped to be ready to run trains in two or three months.

Miscellaneous.

New Court-house.—The Ohio senate authorized, on Feb. 24, the borrowing of an additional $50,000 to build a court-house at St. Clairsville, O.

Cleveland, O., Improvements.—The Bank Street extension is being discussed in the Cleveland Councils. The cost of right of way alone is estimated at from $200 000 to $300,000.

Eggs vs. Cotton.—It is not so long since King-Cotton held sway over our commerce as not to make it seem ridiculous to the average man to suggest that the eggs of this country are worth more than one-third as much as the cotton. The Boston Commercial Bulletin gives the value of the cotton crop annually as $275,000,000 in round figures, but the census of 1880 gave the value of the egg crop as more than $100,000,000.

South Ga. Agricultural College.—The plan and specifications for the building of the South Georgia Agricultural College at Thomasville have been submitted to the trustees by Mr. J. A. Wood, the New York architect, and bids are now being received by the build-

ing committee. When finished it will be a handsome structure.

Gasset Oil Burner Company.—Organized at Saco, Me., Jan. 29th, 1885, to manufacture, deal in and use machines, apparatus and appliances for burning, as fuel, petroleum and its products, with or without gas, from water, for heating and ordinary uses, etc. Capital stock is $100,000. Amount paid in $10. Par value of the shares $10. Owned by Oscar Gasset, Herbert W. Wesson, Ambrose Eastman, of Boston, one share each; balance in treasury; unissued, 9,997. Oscar Gassett is president. Herbert W. Wesson, treasurer. Gassett, Wesson and Eastman are the directors.

Eastern Granite Company.—Organized at Portland, Me., Feb. 7, 1885, for the purpose of carrying on a general quarrying business, and to purchase and acquire such property, real and personal, as may be necessary and convenient for the prosecution thereof. Capital stock is $25,000; amount paid in, $3,000; par value of the shares, $100, Cornelius D. Smith, Boston, 9 shares; Geo. W. Ross, Somerville, 6; F. Montague Sowdon, Boston, 3; Joseph Y. Bradbury, Lowell, Mass., 3; Abel Wheeler, Lowell, Mass., 3; Augustus M. Morgan, Yarmouth, Me., 3; John C. Irvine, Boston, 3; unissued and in treasury, 220. Abel Wheeler is president, and J. C. Irvine, treasurer, and the above-named constitute the directors.

Labor in Demand.—The only country where labor is anxiously wanted just now is along the River Plata in South America, a wonderfully rich country, with a salubrious climate and offering great opportunities. The Buenos Ayres *Standard* says: "Notwithstanding the enormous influx of immigrants there is a great and pressing demand for hands. It is no exaggeration to say that if he arrivals last year had been 200,000 not one of them would now be unemployed. In fact, some of the crops in the upper provinces are lost for want of hands. Only last week some hundred of new arrivals refused $2 a day and beef rations, which is double what they could earn in the United States.

High Freight Tariff.—A clay manufacturing firm in North St. Louis received an order recently from San Francisco for prepared clay and pots for the new glass house of John Campbell & Co. The best rate that could be secured for the four car-loads of prepared clay was $1 05 per hundred weight, or $21 per ton. Fire brick, which the San Francisco firm would have included in their contract, could not be brought here on account of the freight.

The local firm offered them at $28 50 per 1,000, but inasmuch as 1,000 of such brick weigh about 4 tons, the cost per 1,000 of laying down in San Francisco would have been $28 50 plus $84, or $112 50, or $72 50 more per 1,000 than Scotch brick sell at in San Francisco. The same firm in shipping to New Glasgow, N. S., paid only 36 cents per hundred weight from East St. Louis, but it cost $10 to get the car (of 40,000 pounds) across the river.

Using Pigeons in Engineering.—Every one knows, of course, the part which the Pope's stone played in the bitter Know-Nothing fight of 1858, or thereabouts. After this was over, however, and an attempt was made to begin work again upon the [Washington] monument, a very interesting incident occurred. There was no connection with the top of the shaft, and it was a question involving some degree of skill to establish this communication. Several means had been tried in vain, when I suggested the idea of flying pigeons [up inside] to the top. Six pigeons were thereupon brought from my farm in Montgomery county, Md. The idea was to tie a cotton string to the feet of these pigeons, send them up through the interior of the shaft, and then, when they had flown out at the top, to shoot them so that they would fall on the outside, dragging the string with them. We were provided with pistols and guns to make as much noise as possible to scare the pigeons out of the shaft. Five pigeons were in turn sent up; but, unfortunately for the experiment, they rested at intervals in the walls, and no amount of noise could force them to leave their perches. The endeavors to pull them out of the recesses by means of a string left them freer than ever, for the string, of course, broke. The last pigeon was then sent upon its journey. It flew upward until it reached the roof of the monument, but instead of flying out over the top, as intended and hoped, it alighted upon a beam which was lying across the aperture at the top. As if to make the experiment a complete failure, the timber on which the bird alighted was so large that he could not be seen. There was nothing to do then but to wait developments. The bird, after a few minutes of rest, started to fly, but the cord had become entangled around its body in some way, so that it simply dropped helplessly over the timber, but it dropped on the right side. It continued falling, dragging the string with it, until by some manner or other, he, too, lodged in a recess. Ladders were then placed against the side of the interior of the monument. I went up, got the bird, brought him down, and it was then an easy matter, by tying cords of successive thicknesses until a good-sized cable was reached, to establish communication with the top.

The pigeon was then taken and put in a cage and was placed on exhibition, and realized quite a small sum from the admission fees charged to visitors. What became of it finally I don't know.—Joseph H. Bradley, reported in *The Washington Post.*

Contracting.

Suit by Contractors.—Ross & Sanford, dock builders, of Jersey City, and Jones & Benner, contractors, of Philadelphia, have commenced suit in the Hudson County Circuit Court against the Receivers of the Ontario & Western Railroad for $100,000, which amount the plaintiffs claim the company owes them for the construction of piers and sheds at Weehawken.

Sewer Builder's Claim.—E. B. Delamater and J. J. Everson, sewer builders contracted with Cleveland, O., August 10, 1883, to build a sewer in Beecher and Lena Avenues. They made a contract with the Bucyrus Foundry and Manufacturing Company for the construction of an engine, derrick and locomotive, for $2,800 to be used in excavating for the sewer. A lawsuit is the result of this contract. The petition was filed in the Common Pleas Court recently by Delamater & Everson. They say that according to the contract the engine was to be so constructed as to hoist two and a half tons of earth, and suitable in every way for the work for which it was intended. It was to be ready for use within thirty days after the order was given. Everything was in readiness to begin operation in Beecher Street near Dunham, but the engine would not w rk and the derrick would not lift an empty bucket without breaking. It is claimed by Delamater & Everson that the constructors of the engine were compelled to change and alter it in every part and then it would not work. They claimed to have been damaged by this delay, and to have paid out a large sum of money, amounting in all to $2,500. They therefore ask a judgment for this amount.

FOLLOWING BIDS were opened by the Water Commissioners at Buffalo, N. Y., Feb. 27th

FOR CAST-IRON PIPE (per ton of 2240 lbs).

Warren Foundry, New York: 4", $30.10; 6", $29.65; 10", $29.10; 16", $28.70; 24", $26.75; 36", $26.75.

Gloucester Iron Works, Philadelphia: 16", $28.59; 24", $28.35; 36", $28.35.

Dennis Long & Co., Louisville: 4", $29.96; 6", 29.96; 10", $29.96; 16", $29.96; 24", $27.44; 36", $26.88.

Thos. J. McKenna, Buffalo: 16", $28.60; 24", $28.60; 36", $28.60.

George B. Hayes, Buffalo: 4", $29.35; 6", $29.35; 10", $28.77; 16", $28.23; 24", $26.50; 36", $26.32.

SPECIAL CASTINGS PER LB.

Gloucester Iron Works: 16", 24" and 36", 2 1/16c.

Thos. J. McKenna: 16", 24" and 36", 2¼c.

H. G. Prout & Co., Buffalo: 4" and 6", 2c.; 10", 16" and 24", 2⅛c., 36", 3c.

A. R. Ketcham, Buffalo: 4", 6", 10", 16", 24" and 36", 2⅛c.

Thos. J. O'Brien, Buffalo: 4", 6", 10", 16", 24" and 36", 2¼c. City to furnish patterns.

George B. Hayes, Buffalo: 4", 6", 10", 16", 24" and 36", 2c.

THE SUNDRY CIVIL BILL.

The sundry civil bill as reported from the House Appropriation Committee contains the following items, which will be read with interest by contractors:

Botanical garden.—For concreting walks, reconstructing plant house, numbered thirteen, with iron ribs, extending water supplies, and for general repairs $4,600.

Public buildings.—For continuation of post office and court house at Baltimore, Md., $227,000; for one-half cost of constructing stone abutments and piers, for the protection of the custom house, etc., at Bangor, Me., $18,000, the other half to be paid by the city.

Boston court house.—The Secretary of War is authorized to sell at public auction the land and premises known as the old court house, Boston, Mass.

Brooklyn, N. Y.—For continuation of building under present limit, $135,000.

Buffalo, N. Y.—For completion of building under present limit, $37,500.

Charleston, W. Va.—For completion of building and to meet outstanding liabilities, $1,153.30.

Chicago, Ill.—For cleaning and painting stone work and extensive repairs necessary for the preservation of the custom house and subtreasury, $40,000.

Cleveland, Ohio.—For completion of repairs and remodeling custom house, $3,000.

Columbus, Ohio.—For completion of court house and post office, $110,000.

Dallas, Texas.—For completion of court house and post office, $25,000; and the cost of said building, including site, shall not exceed $100,000.

Denver, Col.—For continuation of court house and post office, $28,000.

Frankfort, Ky.—For paving, fences and grading approaches of court house and post office, $5,000; and for retaining wall of lot $5,000.

Fort Wayne, Ind.—For completion of court house and post office, $85,199.12.

Galveston, Tex.—The Secretary of the Treasury is authorized, out of any money heretofore appropriated for the purpose of purchasing a site and erecting a public building in the city to purchase and acquire such additional ground as he may deem necessary, at a cost not exceeding $20,000.

Greensborough, N. C.—For approaches for court house and post office, grading, fencing and paving, $5,000.

Hamilton, Mo.—For completion of post office under present limit, $37,500.

Jackson, Miss.—For approaches of court house and post office, grading, fencing and paving, $5,000.

Jefferson City, Mo.—For completion of court house and post office, $32,000; and the entire cost of said building, including site, shall not exceed $132,000.

Kansas City, Mo.—For completion of approaches, clock, and sewer connections, $15,000.

St. Joseph, Mo.—For continuation of building, $50,000; and the entire cost of said building and approaches, including site, shall not exceed $300,000.

Louisville, Ky.—For continuation, $75,000.

Lynchburg, Va.—For completion of building under present limit, $25,000.

Leavenworth, Kan.—For completion of building, $50,000.

Montgomery, Ala.—For tower clock and completion of approaches, $5,000.

Minneapolis, Minn.—For continuation of building, $110,000; provided that the entire cost of such building shall not exceed $500,000.

New Orleans, La.—For completion, repairs, plumbing and drainage, $15,000.

Peoria, Ill.—For continuation of building under present limit, $50,000.

Poughkeepsie, N. Y.—For completion of building, $30,000.

Philadelphia, Pa.—The Secretary of the Treasury is authorized to sell the old court house and post office.

Quincy, Ill.—For completion of building under present limit, $47,500.

Rochester, N. Y.—For completion under present limit, $80,000.

St. Louis, Mo.—For laundry house and laundry apparatus, of the marine hospital, complete, $10,000.

Shreveport, La.—For approaches, grading, fencing and paving, $5,000.

Syracuse, N. Y.—For completion of building, $38,000.

Terre Haute, Ind.—For completion under present limit, $75,000.

Toledo, Ohio.—For completion of building under present limit, $72,467.42.

Williamsport, Pa.—For completion of building under present limit, $25,000.

LIGHT HOUSES, BEACONS AND FOG SIGNALS.

Romer Shoal Light Station, New York. For establishing a light on Romer Shoal, in the Lower Bay o New York, $20,000.

Winter Quarter Shoal Light Ship, Virginia. For the construction and establishment of an iron light ship, with a fog-signal for Winter Quarter Shoal, Virginia, $30,000.

Bush's Bluff Light Station, Virginia. For a light house and fog bell on Bush's Bluff, Elizabeth River, near Norfolk, Va., $20,000.

For completing the construction of a light house at Grand Marais, Minn., $9,552.

Hunting Island Light Station, South Carolina: For protecting the site of the light house at Hunting Island, S. C., $5,000.

Mosquito Inlet Light Station, Florida: For continuing the light house at Mosquito Inlet, Florida, $30,000.

Anclote Keys Light Station, Florida: For establishing a light at Anclote Keys, Florida, $15,000.

Apalachicola Range Lights, Florida: For range lights to guide into the Apalachicola River, Florida, $600.

Port Sanilac Light Station, Michigan: For completing the construction of a light house at or near Port Sanilac, Lake Huron, Michigan, $10,000.

Detroit River Light House: For the completion of the light house at or near the mouth of the Detroit River, in Lake Erie, $18,000.

Northwest Seal Rock Light Station, California: For continuing the construction of a light house on Northwest Seal Rock, off Point St. George, California, $30,000.

Destruction Island Light Station, Washington Territory: For establishing complete a first order light and fog signal on Destruction Island, Washington Territory, $25,000.

That appropriations made by this act shall not be available before the 1st day of July, 1885, except, where expressly provided herein.

Life Saving Stations: For establishing new life-saving stations and life-boat stations on the sea and lake coasts of the United States, $25,000.

Light House Establishment: For repairs of light houses; for repairs and incidental expenses of light houses and stations; for rebuilding, renovating and improving the same and buildings connected therewith; for the establishing and repairing of pier head lights; and for the purchase and repair of illuminating apparatus and machinery, $300,000.

For Survey of Light House Sites: For examination and survey of sites for proposed light houses and preparing plans for proposed structures, $2,500, provided that the light appropriated for by the act of July 7, 1884, to be established on the west jetty at Saybrook, Conn., may be placed on either jetty, as the Light House Board may select.

For the Maintenance of Lighted Buoys: For the maintenance of light buoys now in use, $5,000.

Index to Periodical Literature.

Aerial Navigation. A demonstration that no sufficient success can be achieved by the aid of balloons, screw propellors, electrical engines etc. The writer recommends that the pneumatic law governing the flight of birds be studied, and gives a brief outline of Wm. Lancaster's experiments in this direction. *The Engineer*, February 6, 1885, pp. 110 and 111.

Architecture. *A Glimpse of some Washington Homes.* A description of some of the homes of more recent construction with illustrations and criticisms. By E. W. Lightner. *Harpers*, March, 1885, pp. 520 to 533.

Architecture. *Recent Architecture in America IV. Churches.* A description and criticism of many examples of recent church building, with many engravings of exteriors and interiors. By Miss Schuyler Van Renesselear. *Century*, January, 1885, pp. 323 to 338.

Bridge—Chestnut Street. *Repairs to the Chestnut St. Bridge, Philadelphia, Pa.* The west abutments, founded on piles in a soft, alluvial bottom, was forced out of position. To prevent further movement four iron cylinders are being placed as struts, extending from the foundation masonry to the bed rock. The article describes the sinking of two of these by the pneumatic process with plans, sections and elevation and with details of the air-lock. *Engineering News*, January, 3, 1885, pp. 12 and 13.

Bridge—Chestnut Street. *Strengthening the Abutment of a Great Bridge.* Descriptive of method of repairing the west abutment of the Chestnut St. Bridge, Philadelphia, Pa., by means of inclined iron cylinder struts, sunk by the compressed air method. Illustrations show the method of doing the work. *Scientific American*, January 10, 1885, pp. 15 and 20.

Bridge Construction. *Plate Girder Bridges.* Practical directions for designing and constructing plate girders, with detail sketches of single and double track bridges. By M. J. Becker. Read before the Ohio Engineers and Surveyors Society. *Engineering News*, January 17, 1885, pp. 33 to 36.

Bridge, Forth. *The Forth Bridge.* A description of the caissons of the Queensferry Pier (one of the center piers, made up of four cylinders, 70 feet in diameter.) Plan, sections, elevations of the caisson and details of the air-lock. *Engineering*, February 6, 1885, pp. 127, 136, 137 and 140.

Bridge, Forth. *The Great Caissons of the Forth Bridge.* A full-page perspective view, and detail sketches showing plan and section with dimensions, of one of the four great caissons (70 feet in diameter) which form each of the central piers. *Engineer*, February, 6, 1885, pp. 105 and 111.

Bridge—Salterhebble. *Piers for the Salterhebble Viaduct.* Illustrations of a novel and somewhat handsome design for masonry piers, in which there is a variation from the usual rectangular outline. Taken from the "*Engineer*" in which there are fuller illustrations. R. R. Gazette, June 13, 1884, p. 442.

Cable Railway, Cost. *Evolution of the Electric Railway.* In this article is given, for comparison with electric propulsion, a detailed table of the cost of construction of a three mile cable R. R., and the cost of operating the same. By Dr. W. Adams. Read before the Engineers Club of St. Louis. *Journal of the Association of Engineering Societies*. October, 1884, p. 327.

Canals—Interoceanic. *Canal Routes between the Atlantic and the Pacific.* A resumé of argument against the Panama Route and in favor of the Nicaraguan Route, by Gardiner C. Hubbard. *Science*, November 7, 1884, pp. 434 to 436.

Car Wheels. *Steel-tired wheels.* A discussion of the question whether the safety and economy of the steel-tired wheel for engines and cars warrant its universal adoption, and of the relative durability value of the various kinds; also of the effects of wrought and cast-iron brakes—shoes on steel wheels, contains data on cost, mileage etc. By the New England R. R. Club. *R. R. Gazette*, February, 13, 1885, pp. 97 and 98.

Cranes, Hydraulic. *see* **Hydraulic Cranes.**

Docks, New York City. *Construction et amenagements des Ports de commerce.* A detailed description of the New Bulkhead Wall, explaining clearly the method and principles of its construction. The wall consists of an embankment of rip-rap, resting on the hard bottom, and faced with a masonry construction of granite and concrete supported on piles. *Annales des Travaux Publics*, September, 1884, p. 1187 to 1189.

Foundations. *see* **Pile Driving.**

Foundations, Ancient. *Foundations of a Roman Bridge in the River Trent.* Account of its discovery, and description of its construction. The foundations consisted of wood set in stone. *Engineering*, October 31, 1884, p. 417.

Foundations, Bridge. *See* **Bridge, Forth.**

Hydraulic Cranes. *Port of Buenos Ayres.* A full page of illustrations, being the first of a series to be devoted to the fine hydraulic machinery made for the improved part of Buenos Ayres. *The Engineer*, February 6, 1885, p. 103.

Lighthouse Illuminants. A statement of the relative merits of oil, gas and electricity as illuminants, compiled from a late Parliamentary return. Professor Tyndall's reasons for asserting the superiority of gas (Wigham system) are controverted by the Trinity house, which advocates oils, the reason being given. The relative powers and economical value of the best lights, as stated by Sir James Douglass, before the British Association Montreal, are also given. *Science*, February 6, 1885, pp. 111 to 113.

Locomotives. *Cost of Locomotive Power for six months, ending December 20, 1884, on the Liverpool and Manchester England, Railway.* A table giving, for each of forty engines, the miles run, coke, oil, tallow, and water consumed, wages, cost of repairs, proportion of general changes and total cost for six months and the average per mile run, and a table of general averages, in the same detail, for all the engines. *The Engineer*, February 6, 1885, p. 97.

Navy. *Our New Cruisers.* A description of the cruisers just laid down for the Navy (U. S.) going fully into the details, with illustrations of the details of the "Chicago," "Boston," "Atlanta" and Dolphin. By Assistant Naval Contractor F. T. Bowles, U. S. N. *Pro. U. S. Naval Institute*. Vol. IX. No. 4, 1883.

Pavements. *History of Cleveland Pavements*, from the earliest pavements to date, describing such kind laid, the method of laying, its cost and wear. The writer states only *facts*, postponing to some future time the conclusions derived from his studies. By M. E. Rawson. Read before the Civ. Engrs. Club of Cleveland. *Assn. of Engineering Societies*, Oct., 1884, pp. 298 and 309.

Pile Driving. *Railroad Pile Driver.* A detailed description with illustrations of a steam pile-driver attached to a self-propelling car. The outfit, complete for driving long piles in trestles is carried on a car 36 feet long by 10 feet wide. Used on the Flint & Pere Marquette R. R. *R. R. Gazette*, May 9, 1884 pp. 352 and 353.

Pile-Driving, Water-Jet. *Chronology of the Water-Jet as an aid to Engineering Construction.* A list of the works in which it was used, and the methods of its applications at these places, down to the year 1880. *Engineering News*, Feb. 14, 1885, pp. 104, 105.

Pneumatic Transmission. *Pneumatic system of the Western Union.* A description of the line on Broadway between Dey and W. Twenty-third St. Method of construction and operation. Capacity, speed, etc., with illustrations. *Scientific American*, Feb. 14, 1885, pp. 95 and 100.

Railroads: *See* **Car Wheels, Locomotives, Railroad, Cable;** *see* **Cable Railways.**

Market Report of Engineering Materials.

New York, February 26, 1885.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer, and both the range of material and the market location will be extended as rapidly as possible. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

STRUCTURAL IRON.		
Angles	2.2c. @	2.6c.
Tee	2.8c. @	3c.
Beams and channels	3.0c. @	3.5c.
Tank	2c. @	2.1c.
Shell	2¾c.	
Steel plates, Tank	3c. @	3¼c.
WROUGHT-IRON PIPE, PITTSBURGH.		
Butt welded, black ..Discount	47½	
" " galvanized "	40	
Lap welded black "	65 @	67½
" " Galvanized "	47½ @	50
Boiler tubes "	60	
RAILS.		
Steel (large lots at mill)	$27 @	28
Old rails	17.50	
Old rails, steel	16 @	17
R. R. spikes		3c
R. R. splice-plates	1.65c. @	1.75c.
R. R. Track Bolts	2¼ @	2½
Barb-wire fencing, galvanized	4¾c. @	5¼c.
" " painted	3¾c. @	4¼c.
Corrugated iron		
Nails		
Iron	2.25	
Steel	2.35	

METALS.

COPPER.		
Lake Superior	11 @	.11¼
Other Brands	10¾ @	10¾
LEAD.		
Com. Domestic	3.60 @	3.70
Lead Pipe	.06¾	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.06¾	
ZINC.		
Sheet	5.15 @	5.25

BRICK.

(Cargoes afloat)		
Haverstraw 1st per M.	$6.00 @	6.25
" 2nd "	5.62 @	5.87
Fishkill	4.75 @	5.50
Up-River		
Jerseys	5.25 @	
Long Island		
" pale		
FRONTS.		
Croton red	14.00 @	
" dark	14.00 @	
" brown	12.00 @	
Philadelphia pressed	22.50 @	23.00
Trenton "	22.50 @	23.00
Baltimore "	37.00 @	41.00
Buff "	33.00 @	35.00
Enameled English	65.00 @	130.00
" American	85.00 @	120.00
Fire brick	25.00 @	40.00

CEMENT.

PORTLAND.		
Robins & Co., Extra English 425 lbs. per bbl.	2.75 @	2.80
K. B. & S. English 400 lbs.	2.85 @	3.00
Burham " "	2.70 @	2.85
Rochester Castle " "	2.50 @	2.60
J. B. White & Bro. " "	2.50 @	2.60
Other brands, " "	2.40 @	2.50
Keene's fine " "	9.50 @	9.75
" course " "	5.25 @	5.50
Roman	2.75 @	3.50
Dyckerhoff, German 400 lbs.	2.60 @	2.65
Star, " "	2.60 @	2.65
Alsen, " "	2.55 @	2.60
Hanover " "	2.40 @	2.50
Other brands, " "	2.35 @	2.40
Saylor's American	2.15 @	2.50
F. O. Norton	1.10	
Rosendale cements	0.90 @	1.00

LIME.

Rockland common per bbl.	1.00	
" finishing	1.20	
Glensfalls, common	.85	
" finishing	1.05 @	1.10
Kingston, ground	0.95	

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.90 @	95
" " No. 2 "	0.75 @	0.80
" " light drab "	0.80 @	0.95
Berlin " in rough "	0.75 @	1.00
Berea " "	0.75 @	1.00
Brownstone, Portland, Ct. "	1.00 @	1.30
" Belleville, N. J. "	0.75 @	1.25
Granite, rough	0.60 @	1.25
Common building stone per load	2.00 @	3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40 @	3.00

SLATE.

Purple roofing per square	6.00 @	7.00
Green "	6.00 @	7.00
Red "	15.00	
Black Penna. (at New York) "	4.50 @	5.00

LUMBER.

PINE, Common box per M.	18.00 @	20.00
" Good "	55.00 @	60.00
Tally plank, 1¼ in each.	.44 @	.50
Tally boards, dressed "	.28 @	.30
SPRUCE, Boards dressed "	.25 @	.28
Plank, 1¼ in "	.28 @	.30
" 2 in. "	.38 @	.40
" 2 in. dressed "	.43 @	.45
Timber per M.	20.00 @	22.00
HEMLOCK, Boards each.	.18 @	.20
Joist, 2¼ × 4 to 4 × 6 in	.17 @	.44
OAK per M.	55.00 @	65.00
CYPRESS 1, 1¼, 2 and 2¼ in "	35.00 @	40.00
YELLOW PINE, Girders "	26.00 @	35.00
Dressed flooring "	30.00 @	40.00
SHINGLES, Extra shaved pine, 18in. "		
" " sawed 18 in. "	4.50 @	5.00
LATH, Cargo rate "	2.50 @	2.60

PAINT.

Lead, white, American dry per lb	.04¾ @	.05
" " in oil pure "	.05¾ @	.05¾
English, B. B. in oil "	.08¾ @	.08¾
Red, American "	.05¾ @	.05¾
Litharge "	.05 @	.05¼
Venetian red, American "	.01 @	.01¼
Indian red "	.05 @	.10
Vermillion, American lead "	.11 @	.11¼
Paris green "	.15 @	.19
Umber, Amer. raw and powdered per lb.	.01¼ @	.01¾
Drop black, Amer. "	.08 @	.12
" " "	.09 @	.11¼
Chrome green	.05 @	.15
Oxide zinc, American	.03½ @	.04
" French	.06¼ @	.06¾

THE recent improvements in *Engineering News* are sufficiently marked to attract attention from all quarters. Its typographical neatness, its numerous illustrations, its reliability, its determination to keep abreast with the times, and its inroads upon the kindred professions which it impinges make it the most popular and profitable weekly journal of its class. Published in the *Tribune* Building, New York. Edited by Geo. H. Frost and D. McN. Stauffer, practical civil engineers.—Phila. *Evening Call*, Feb. 27th, 1885.